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VOLUME XVI, 1924

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MYCOLOGIA

IN CONTINUATION OF THE JOURNAL OF MYCOLOGY

Founded by W. A. Kellerman, J. B. Ellis, and B. M. Everhart in 1885

EDITOR

WILLIAM ALPHONSO MURRILL

Volume XVI, 1924

With 20 Plates and 12 Figures.

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ISLAND AND TOWN OF ST. THOMAS

MYCOLOGIA

VOL. XVI JANUARY, 1924 NO. 1

THE FUNGOUS FLORA OF ST. THOMAS

FRED J. SEAVER

(WITH PLATES 1–3)

During March of the present year the writer had the rare privilege of spending a week on the little island indicated by the title of the present paper in connection with the scientific survey which is being made of Porto Rico and the Virgin Islands by the New York Academy of Sciences. The mycological work which was assigned to the writer was conducted under the auspices of the New York Botanical Garden and the Department of Agriculture and Labor of Porto Rico, and to these institutions I am indebted for the opportunity of visiting these quaint and secluded little islands which have so recently become a part of our own country by purchase.

Leaving Porto Rico late in the evening of March 9 by the steamer "Marina," after a voyage which was calm, but which is likely to be rough more on account of the small size of the steamer than the severity of the wind, we arrived in the harbor of St. Thomas just as the day was beginning to dawn. The quiet town nestling in the foothills of the mountains, which rise quite abruptly from the shore, as seen from across the sheltered bay, with her ships peacefully at anchor, presented a picture not easily forgotten, and scarcely to be excelled in the beauty of its natural setting (See frontispiece). As the day advances, the hills, which by dim light appeared most luxuriant, are seen to be rather arid, which, while it may lessen their value agriculturally and botanically, detracts little from their natural beauty.

[MYCOLOGIA for November (15: 245–289) was issued December 21, 1923]

The island, which is about thirteen miles long and three or four miles wide, is, for the most part, mountainous, the peaks of the hills rising to an elevation of 700–1,400 feet. There are no extended automobile roads, and many parts of the island can be reached only on foot or by horseback.

Like other tropical islands, the heat, which would otherwise be intense, is tempered by the everblowing trade winds. The daily variation is only about nine degrees, so that on the whole the temperature is not oppressive, and, by reason of the arid conditions, the climate is most healthful. The rainfall averages around forty-six inches per year, or approximately that of our own section (New York). This amount is scarcely sufficient for successful agriculture, considering the excessive evaporation resulting from the continuous heat and drying winds. The lay of the ground is also such that when it rains excessively, as it does at times, the water runs off quickly, leaving the hillsides parched and dry, and not particularly favorable for mycological work. Doubtless forestation of the hills, if it could be accomplished, would do much to retain the moisture and improve the island both agriculturally and botanically.

Unfortunately, the few remaining hills which are covered with large trees are being rapidly denuded. According to an old resident, within his memory valleys, or "guts" as they are called, which were wooded and abounding in fungi are now naked and dry. Whether the majority of the hills were ever heavily forested is a question, but, so far as we can judge from accounts, the island has never been agriculturally prosperous. Whether man can do for the island what nature has failed to do is difficult to say, but that conditions might be improved by artificial means can not be questioned.

It is an agreeable surprise for an American coming from Porto Rico and not familiar with Spanish to find English spoken exclusively in this island in spite of the fact that it had been under Danish rule for many years. This, together with the healthfulness of the climate, ought to make St. Thomas an attractive winter resort for those Americans who wish to escape the rigors of a northern climate and prefer quiet rest to the excitement of the average summer resort.

During our stay in the island we made our headquarters in St. Thomas, the only town on the island, reaching into the outlying districts, using "autos" where possible and when otherwise using horses or tramping. March 10 was spent near the town, or as far west as Mosquito Bay. One day (March 11) was spent on or near the Louisenhöj estate, belonging to Mr. Arthur Fairchild, and located in the hills above the town at an elevation of 800 feet, our collecting reaching from here down the opposite side of the island to Bucks Bay. March 12 was spent along the shore as far west as John Bruce Bay, and the following day in the vicinity of Mandal in the opposite direction.

The longest trip made was from St. Thomas to Botany Bay at the extreme western end of the island. This expedition was made in company with Prof. Kemp of Columbia University, the purposes being mainly geological. The horses for this outing were furnished by Mr. Axel Holst, whose "week-end" cottage on Botany Bay was opened to us on this occasion. The mycological work at this point was not very satisfactory, although the trip itself was most delightful, and some of the mountain regions through which we passed looked promising had we had time to stop.

The most fruitful day on the island, from a mycological point of view, was March 16, which was spent on the mountain range west of Louisenhöj in the ravine known as St. Peter's "gut" and in its general vicinity. Mr. Adolph Sixto, an enthusiastic naturalist and loyal resident, acted as guide. Although the collecting was very favorable, he repeatedly assured the writer that, owing to recent destruction of the forests, conditions were not what they once were.

While several papers have been published on the fungi of St. Thomas and the other American Virgin Islands, the work has been done mostly by Europeans, so far as known no American mycologist having previously visited the islands. The most complete and recent record is that of C. Ferdinandsen and Ø. Winge.[1] In this paper reference is made to other lists previously published, including those of E. Fries[2] and Borgensen and Paulsen.[3] Since so

[1] C. Raunkiaer, Fungi from the Danish West Indies collected 1905–1906, Part 1.—Bot. Tidssk. 29: 1–25. 1908.

[2] E. Fries, Novae Symbolae Mycologicae (various pages).

little is known of the fungi of the Virgin Islands, especially St. Thomas, it is thought worth while to summarize our knowledge of the larger islands separately, the present paper being concerned with St. Thomas. The species reported for the first time are indicated in **bold-face type.** Starred (*) species are those re-collected. The writer is indebted to Dr. W. A. Murrill for determination of the most of the basidiomycetes collected, as well as for comments on those previously reported. The rusts were determined by Dr. J. C. Arthur, and the one slime mould by Professor T. H. Macbride.

SUMMARY OF THE WORK

One hundred and nine species of fungi are here recorded for St. Thomas (excluding the doubtful records), fifty-four of which were collected for the first time during our stay of one week in the island. Of these, seven are described as new. Of the fifty-five species based on previous records, only fourteen were re-collected by us. The small amount of duplication would suggest a rather extensive fungous flora, in spite of the arid conditions prevailing there.

MYXOMYCETES

Stemonitis splendens Rost. Sluz. Monog. 195. 1875.
On rotten wood. Collected in the vicinity of St. Peter.
Macbride (in litt.) considers this the true *S. splendens* originally described by Rostafinski from tropical material collected in the northern part of South America. North American plants described as *Stemonitis Morgani* by Peck, and later made a synonym of the above, Macbride still thinks are distinct from the tropical form.

PERONOSPORALES

Albugo platensis (Speg.) Swing. Jour. Myc. 7: 113. 1892.
Cytospora platensis Speg. Rev. Argent. Hist. Nat. 1: 32. 1891.
On *Boerhaavea erecta* L. Collected near Mandal.

PERISPORIALES

MELIOLA ASTERINOIDES Winter, Hedwigia 25: 96. 1886.
Reported by Ferdinandsen & Winge on *Piper peltatum* L.
An immature specimen of what appeared to be a *Capnodium* was also reported by Ferdinandsen & Winge on *Mangifera indica* L.

[3] F. Børgesen and O. Paulsen. Om Vegetationen paa de dansk-vestindiske Øer. Bot. Tidssk. 22: 111–113. 1898.

DOTHIDEALES

Catacuma palmicola Stevens, Bot. Gaz. 69: 251. 1920.
On *Coccothrinax argentea* (Lodd.) Sargent. Collected in hills near St. Thomas.

Phyllachora Crotonis (Cooke) Sacc. Syll. Fung. 2: 599. 1883.
Dothidea Crotonis Cooke, Grevillea 10: 129. 1882.
On living leaves of *Croton Astroites* Dryand. Collected in hills near St. Thomas. The spores of our specimens are rather larger than indicated for this species, being about 10 x 20 μ. However, it is thought best to refer these plants to the above name.

* PHYLLACHORA GRAMINIS (Pers.) Fuckel, Symb. Myc. 216. 1869.
Sphaeria graminis Pers. Obs. Myc. 1: 18. 1796.
On various grasses. Reported from St. Thomas.

Phyllachora Nectandrae Stevens & Dalby, Bot. Gaz. 68: 57. 1919.
On *Nectandra coriacea* (Sw.) Griseb. Collected in hills near St. Thomas.

? **Phyllachora serjaniicola** Chardon, Mycologia 13: 293. 1921.
On *Serjania polyphylla* Radlk. Collected in hills near St. Thomas.
Specimens do not show spores, but spots seem characteristic.

HYPOCREALES

Chromocreopsis bicolor (Ellis & Ev.) Seaver, Mycologia 2: 64. 1910.
Hypocrea bicolor Ellis & Ev. Jour. Myc. 4: 58. 1888.
On decaying wood. Collected near St. Thomas.

CREONECTRIA GRAMMICOSPORA (Ferd. & Winge) Seaver, Mycologia 1: 192. 1909.
Nectria grammicospora Ferd. & Winge, Bot. Tidssk. 29: 11. 1908.
On dead branches. Reported from the island of St. Thomas.

CREONECTRIA OCHROLEUCA (Schw.) Seaver, Mycologia 1: 190. 1909.
Sphaeria ochroleuca Schw. Trans. Am. Phil. Soc. II. 4: 204. 1832.
Reported from St. Thomas under the name of *Nectria vulgaris* Speg., which is now regarded as a synonym of the above.

Hypomyces rosellus (Alb. & Schw.) Tul. Ann. Sci. Nat. IV. 13: 12. 1860.
Sphaeria rosella Alb. & Schw. Consp. Fung. 35. 1805.
On *Auricularia nigrescens* (Sw.) Farl. Collected in the vicinity of St. Peter.

Nectria episphaeria (Tode) Fries, Summa Veg. Scand. 388. 1849.
Sphaeria episphaeria Tode, Fungi Meckl. 2: 21. 1791.
On old fungi. Collected in the vicinity of St. Peter.

NECTRIA SUFFULTA Berk. & Curt.; Berk. Jour. Linn. Soc. 10: 378. 1868.
On dead *Musa*. Reported from St. Thomas under the name of *Nectria setosa* Ferd. & Winge, which is now regarded as a synonym of the above.

STILBOCREA HYPOCREOIDES (Kalchbr. & Cooke) Seaver, Mycologia 2: 62. 1910.
Sphaerostilbe hypocreoides Kalchbr. & Cooke, Grevillea 9: 26. 1880.
On bark of trees. Described as new from St. Thomas under the name of *Sphaerostilbe intermedia* Ferd. & Winge, which is now regarded as a synonym of the above.

FIMETARIALES

Pleurage arachnoidea (Niessl) Griff. Mem. Torrey Club 11: 73. 1902.
Podospora arachnoidea Niessl; Krieger, Fung. Sax. exsicc. *371*; Hedwigia 35: (143). 1896.
On cow dung. Collected near St. Thomas.

SPORORMIA INTERMEDIA Auersw. Hedwigia 7: 67. 1868.
On donkey dung. Reported from Lövenlund.

SPHAERIALES

* DALDINIA CONCENTRICA (Bolt.) Ces. & DeNot. Comm. Critt. Ital. 1: 198. 1863.
Sphaeria concentrica Bolton, Fungi Halifax 3: 180. 1791.
On dead wood. Collected near Louisenhöj.

* DALDINIA ESCHSCHOLZII (Ehrenb.) Rehm, Ann. Myc. 2: 175. 1904.
Sphaeria Eschscholzii Ehrenb. Horae Physicae 89. 1820.
On dead wood. Common.
Perhaps only a large form of the preceding.

EUTYPA AURANTIICOLA Speg. Anal. Soc. Ci. Arg. 26: 26. 1888.
On stumps of wood. Reported from Crown.

Eutypa flavovirescens (Hoffm.) Sacc. Syll. Fung. 1: 172. 1882.
Sphaeria flavovirescens Hoffm. Veg. Crypt. 1: 10. 1787.
Eutypa flavovirens Tul. Fung. Carp. 2: 57. 1863.
On old wood. Collected near St. Thomas.

Guignardia pipericola Stevens, Trans. Ill. Acad. Sci. 10: 183. 1917.
One specimen in the herbarium of The New York Botanical Garden was collected by E. G. Britton and Delia W. Marble on *Piper medium* Jacq., east of Charlotte Amalia.

Hypoxylon annulatum (Schw.) Mont. in C. Gay, Hist. Chil. Bot. 7: 445. 1854.
Sphaeria annulata Schw. Jour. Acad. Sci. Phila. 5: 11. 1825.
On old wood. Collected near Mandal and John Bruce Bay.

HYPOXYLON PSEUDOPACHYLOMA Speg. Bol. Acad. Ci. Cordoba 11: 206. 1887.
On dead branches. Reported from near St. Thomas.

* HYPOXYLON RUBIGINOSUM (Pers.) Fries, Summa Veg. Scand. 384. 1849.
Sphaeria rubiginosa Pers. Syn. Fung. 11. 1801.
On dead wood. Collected in hills near St. Peter.

Lizonia Jacquiniae Bri. & Har. Rev. Myc. 13: 16. 1891.
On *Jacquinia Barbasco* (Loefl.) Mez. Collected near St. Thomas.
While no authentic specimens of this species have been seen, our plants seem to conform well with the original description.

NUMMULARIA GLYCYRRHIZA (Berk. & Curt.) Sacc. Syll. Fung. 1: 401. 1882.
Hypoxylon Glycyrrhiza Berk. & Curt. Jour. Acad. Nat. Sci. Phila. II. 2: 285. 1853.
On old wood. Collected near St. Thomas.

Nummularia repanda (Fries) Nitsch. Pyrenom. Germ. 57. 1867.
Sphaeria repanda Fries, Obs. Myc. 1: 168. 1815.
On dead wood. Collected in the vicinity of St. Peter and in St. Thomas.

NUMMULARIA DURA Ferd. & Winge, Bot. Tidssk. 29: 15. 1908.
On bark of trees. Reported from Lövenlund.

Otthia hypoxyloides Ellis & Ev. N. Am. Pyrenom. 249. 1892.
Amphisphaeria Hypoxylon Ellis & Ev. Jour. Myc. 2: 41. 1886.
On old branches. Collected in St. Thomas.

Physalospora Andirae Stevens, Trans. Ill. Acad. Sci. 10: 184. 1917.
On *Andira inermis* H.B.K. [*Andira jamaicensis* (W. Wr.) Urb.]. Collected near Bucks Bay.

Rosellinia Bresadolae Theiss. Ann. Myc. 6: 351. 1908.
On decorticated branches. Collected in the vicinity of St. Peter.
Characterized by its conical perithecia, and fusiform and flattened spores. The specimen seems to agree with the description of the above based on material collected in Brazil, although no mention is made of the flattened spores in that species.

Rosellinia melaleuca Ellis & Ev. Bull. Lab. Nat. Hist. State Univ. Iowa 2: 402. 1893.
On wood. Collected near St. Thomas.

Rosellinia subiculata (Schw.) Sacc. Syll. Fung. 1: 255. 1882.
Sphaeria subiculata Schw. Nat. Ges. Leipzig 1: 44. 1822.
On old wood. Collected in the vicinity of St. Peter.

Ustulina vulgaris Tul. Fung. Carp. 2: 23. 1863.
On dead wood. Collected in the vicinity of St. Peter.

Xylaria appendiculata Ferd. & Winge, Bot. Tidssk. 29: 17. 1908.
On dead leaf. Collected in the hills near St. Thomas.
Material collected by the writer agrees with the original description of the above species in presenting both the *Hypoxylon* and *Xylaria* type of stroma on the same substratum. These were at first thought to be different species, but were later found to, apparently, be different forms of the same plant.

Xylaria Hypoxylon (L.) Grev. Fl. Edin. 355. 1824.
Clavaria Hypoxylon L. Fl. Suecica ed. II. 457. 1755.
On wood. Collected near St. Thomas and in the vicinity of St. Peter.

* XYLARIA SESSILIS Ferd. & Winge, Bot. Tidssk. 29: 18. 1908.
On wood. Collected near St. Thomas.

Xylaria subtorulosa Speg. Bol. Acad. Nac. Ci. 11: —137. 1889.
On wood. Reported from St. Thomas and Crown.

PEZIZALES

ASCOPHANUS CARNEUS (Pers.) Boud. Ann. Sci. Nat. V. 10: 250. 1869.
Ascobolus carneus Pers. Syn. Fung. 676. 1801.
On donkey dung. Reported from St. Thomas.

Bactrospora integrispora sp. nov.
Apothecia scarcely more than one half mm. in diameter, black, disc-shaped, usually with a slightly elevated margin, thickly scattered over the surface of the substratum; asci subcylindric with an abruptly attenuated base and short stem, about 70 x 10 μ; spores cylindric, 7–8-septate (septa often indistinct), 50 x 2–2.5 μ, not breaking into segments in the ascus.
On decorticated surface of some unidentified tropical wood.
Type collected March 10, 1923, near St. Thomas.

Dermatea dimorpha sp. nov.
Pycnidial stage consisting of club-shaped or flask-shaped bodies 1–2 mm. high, either occurring separately or associated with and often fused to the base of the apothecia; pycnidia more or less angular, about 2 μ in diameter; apothecia usually cespitose, sessile or substipitate, shallow-cup-shaped, with a purplish tint, the hymenium slightly darker, reaching a diameter of 1–2 mm.; asci clavate, about 40 x 4 μ; spores usually 1-seriate, ellipsoid, often with two small oil drops, 2 x 4 μ.
On dead branches of some undetermined shrub or vine; also on dead wood of some tree.
Type collected March 11, 1923, at the estate, Louisenhöj.

Niptera subiculata sp. nov.
Apothecia gregarious, sessile, saucer-shaped, externally whitish; hymenium pale-yellow, reaching a diameter of about 1 mm.; asci 8-spored, 60–75 x 6 μ; spores 1-seriate or slightly crowded, ellipsoid, 1-septate, 8–10 x 2–2.5 μ.
On a black subiculum on a rotten stick, accompanying *Rosellinia subiculata* (Schw.) Sacc. Collected in the vicinity of St. Peter.

Patellaria atrata (Hedw.) Fries, Syst. Orbis Veg. 113. 1825.
Lichen atratus Hedw. Laub. Moose 2: 73. 1789.
On old wood, near St. Thomas.

In addition to the species of cup fungi listed, spores of a *Saccobolus* and a species of *Lasiobolus* were found on dung. Neither species could be determined with certainty, and both were too fragmentary to justify ascribing names to them.

HYSTERIALES

Gloniopsis guttulata sp. nov.

Apothecia in clusters on the substratum, usually parallel, straight or very slightly curved, reaching a length of 1 mm.; asci clavate, 8-spored; spores ellipsoid or ovoid, thickly crowded with large guttulae, which apparently mark the spaces between the septa, giving the spore a muriform structure, about 14 x 7 μ, hyaline.

On the decorticated surface of some tropical wood. Collected near St. Thomas.

Hysterium Calabash sp. nov.

Apothecia gregarious in little clusters on the substratum, straight or curved, reaching a length of 1 mm.; asci clavate, reaching a length of 70 μ and a diameter of 10 μ, 8-spored; spores fusoid, 3-septate, slightly constricted at the septa, pale-brown, about 18 x 8 μ.

On the surface of dried calabash fruit. Collected near St. Thomas.

PHACIDIALES

Tryblidium rufulum (Spreng.) Ellis & Ev. N. Am. Pyrenom. 690. 1892.
Hysterium rufulum Spreng. Vet. Akad. Handl. 1820: 50. 1820.
On dead sticks. Common.

FUNGI IMPERFECTI

PHYLLOSTICTALES

DARLUCA FILUM (Biv.) Sacc. Syll. Fung. 3: 410. 1884.
Sphaeria Filum Biv.-Bern. Stup. Rar. Manip. 3: 12. 1815.
On *Puccinia Synedrellae* P. Henn. Reported from Lövenlund.

MELOPHIA EUGENIAE Ferd. & Winge, Bot. Tidssk. 29: 20. 1908.
On living leaves of *Eugenia* sp. Reported from Lövenlund.

Phoma lathyrina Sacc. Michelia 2: 274. 1881.
On pods of *Albizzia Lebbeck* (L.) Benth. Collected in the vicinity of St. Peter.

Phoma Leonotidis sp. nov.

Pycnidia thickly scattered over the substratum, immersed, small, reaching a diameter of 100–125 μ; spores minute, ellipsoid, about 2–3 x 4–6 μ, hyaline, usually containing two small oil-drops.

On dead stems of *Leonotis nepetaefolia* (L.) R. Br.

HYPHOMYCETES

Didymaria Solani sp. nov.

Forming rusty-brown spots on the substratum, 3–5 mm. in diameter, visible on both sides of the leaf, but producing fruit on the under side only (so far as observed); sporophores forming sori almost entirely covering the infected area, comparatively short, and reaching a diameter of 6 μ, sparingly branched; spores at first globose, elon-

gating, and finally becoming ellipsoid to cylindric, 1-septate, reaching a length of 20 μ and a diameter of 8 μ.
On living leaves of *Solanum* sp. Collected near Mandal.

FUMAGO VAGANS Pers. Myc. Eu. 1: 9. 1822.
On leaves of *Piper medium* Jacq. and *Mangifera indica* L. Reported from St. Thomas.

HETEROSPORIUM REPANDUM Ferd. & Winge, Bot. Tidssk. 29: 23. 1908.
On dry branches. Reported from Lövenlund.

OIDIUM CYPARISSIAE Syd. Hedwigia 36: (163). 1879.
On *Euphorbia* sp. Reported from Lövenlund.

PUCCINIOPSIS CARICAE (Speg.) Seaver comb. nov.
Cercospora? Caricae Speg. Ann. Soc. Ci. Argent. 22: 215. 1886.
Pucciniopsis Caricae Earle, Bull. N. Y. Bot. Garden 2: 340. 1902.
On decaying leaves of *Carica Papaya* L. Reported from St. Thomas and Lövenlund.

STILBUM HEVEAE (A. Zimm.) Sacc. & P. Sacc. Bull. Inst. Buitz. 10: 21. 1901.
Stilbella Heveae Zimm.; P. Henn. Hedwigia 41: 148. 1902.
On stumps of wood. Reported from St. Thomas.

STILBUM KARSTENII Sacc. Syll. Fung. 10: 682. 1892.
Associated with *Sphaerostilbe intermedia* Ferd. & Winge. Reported from St. Thomas.

TUBERCULINA PERSICINA (Ditm.) Sacc. Fungi Ital. *f. 964.*
Tubercularia persicina Ditm. in Sturm. Deuts. Fl. Pilze 1: 99. 1817.
On *Puccinia Raunkiaerii* Ferd. & Winge. Reported from St. Thomas.

STERILE MYCELIUM

SCLEROTIUM VULGATUM Fries, Obs. Myc. 1: 204. 1815.
On human excrement. Reported from St. Thomas.

USTILAGINALES

USTILAGO FIMBRISTYLIS Thüm. Bull. Torrey Club 6: 95. 1876.
On *Fimbristylis diphylla* (Retz.) Vahl. Reported from Crown.

UREDINALES

AECIDIUM CIRCUMSCRIPTUM Schw.; Berk. & Curt. Jour. Phila. Acad. Sci. 2: 283. 1853.
Aecidium Cissi Wint. Hedwigia 23: 168. 1884.
On *Cissus sicyoides* L. Reported from Crown and Lövenlund.

PUCCINIA BLECHI Lagerh. Bull. Soc. Myc. Fr. 11: 214. 1895.
On *Blechum Brownei* Juss. Reported from Lövenlund.

PUCCINIA CRASSIPES Berk. & Curt.; Berk. Grevillea 3: 54. 1874.
On *Ipomoea* sp. Reported from Lövenlund under the name of *Puccinia Ipomoeae panduranae* (Schw.) Syd.

Puccinia esclavensis Diet. & Holw.; Holway, Bot. Gaz. **24**: 29. 1897.
On *Valota insularis* (L.) Chase. Collected near St. Peter.
Species new to the West Indies, although common on the continent.

PUCCINIA HETEROSPORA Berk. & Curt. Jour. Linn. Soc. **10**: 356. 1869.
On *Sida* sp. Reported from Lövenlund.

Puccinia Hyptidis (M. A. Curt.) Tracy & Earle, Bull. Miss. Exp. Sta. **34**: 86. 1895.
Uredo Hyptidis Curt. Am. Jour. Sci. II. **6**: 353. 1848.
On *Hyptis capitata Jacq.* Collected in the vicinity of St. Peter.

Puccinia impedita Mains & Holw.; Arth. Mycologia **10**: 135. 1918.
On *Salvia coccinea* Juss. Collected near St. Thomas.

Puccinia invaginata Arth. & Johnst. Mem. Torrey Club **17**: 146. 1918.
On *Gouania polygama* (Jacq.) Urban. Collected near St. Thomas.

* PUCCINIA LANTANAE Farl. Proc. Amer. Acad. Sci. **18**: 83. 1883.
On *Lantana camara* L.? Collected in the vicinity of St. Peter. Also collected by Dr. J. N. Rose.

* PUCCINIA LEONOTIDIS (P. Henn.) Arth. Mycologia **7**: 245. 1915.
Uredo Leonotidis P. Henn. in Engler Pfl. Ost.-Afr. **C**: 52. 1895.
On *Leonotis nepetaefolia* (L.) R. Br. Reported from Lövenlund under the name of *Puccinia leonotidicola* P. Henn. Also collected at Mandal.

PUCCINIA MACROPODA Speg. An. Soc. Ci. Arg. **10**: 8. 1880.
On *Iresine elatior* L. C. Rich. Reported from Lövenlund.

* PUCCINIA OBLIQUA Berk. & Curt. Jour. Linn. Soc. **10**: 356. 1858.
On *Metastalma* sp. Collected near St. Thomas. Also reported by Dr. Arthur, Mycologia **7**: 242.

PUCCINIA OPULENTA Speg. Fung. Arg. **1**: No. 36. 1880.
On Convolvulaceae. Collected by Dr. J. N. Rose.

PUCCINIA RAUNKIAERII Ferd. & Winge, Bot. Tidssk. **29**: 8. 1908.
On petioles and leaves of *Rivina humulis* L. Described from St. Thomas.

Puccinia Scleriae (Paz.) Arth. Mycologia **9**: 75. 1917.
Rostrupia Scleriae Paz. Hedwigia **31**: 96. 1892.
On *Scleria pterota* Presl. Collected in the vicinity of St. Peter.

PUCCINIA SYNEDRELLAE P. Henn. Hedwigia **37**: 277. 1898.
On *Synedrella nodiflora* (L.) Gaertn. Reported from Lövenlund.

PUCCINIA URBANIANA P. Henn. Hedwigia **37**: 278. 1898.
On *Stachytarpheta* sp. Reported from Crown.

PUCCINIOSIRA PALLIDULA (Speg.) Lagerh. Tromsø. Mus. Aarsh. **16**: 122. 1894.
Coleosporium (?) *pallidulum* Speg. Anal. Soc. Ci. Argent. **17**: 95. 1884.
On *Triumfetta* sp. Reported from St. Thomas under the name of *Pucciniosira Triumphettae* Lgh.

Ravenelia Stevensii Arth. Mycologia 7: 178. 1915.
On *Acacia riparia* H.B.K. Collected near St. Thomas.

UREDO COMMELINAE Speg. Anal. Soc. Ci. Argent. 9: 172. 1880.
On *Commelina* sp. Reported from Lövenlund.

Uromyces Caesalpiniae Arth. Mycologia 7: 183. 1915.
Ravenellia Caesalpiniae Arth. Bull. Torrey Club 31: 5. 1904.
On *Mimosa ceratonia* L. Collected in the vicinity of St. Peter.

Uromyces Dolicholi Arth. Bull. Torrey Club 33: 27. 1906.
On *Dolicholus reticulatus* (Sw.) Millsp. Collected near St. Peter.
Cajan Cajan (L.) Millsp. Collected near St. Peter.

Uromyces gemmatus Berk. & Curt.; Berk. Jour. Linn. Soc. 10: 357. 1869.
On *Jacquemontia nodiflora* (Desv.) G. Don. Collected near St. Thomas.

AURICULARIALES

Auricularia nigrescens (Sw.) Farl. Bib. Index 1: 308. 1905.
Peziza nigrescens Sw. Prodr. 150. 1799.
On wood. Collected in St. Peter's Gut.

AGARICALES

COPRINUS ARMILLARIS Fries, Nova Acta Soc. Sci. Upsal. III. 1: 28. 1855.
Known only from St. Thomas.

* COPRINUS EPHEMERUS Pers. Syn. Fung. 406. 1801.
On dung. Reported from St. Thomas by Fries. Also specimens grown in culture on dung from St. Thomas appear to conform to the requirements of this species.

COLTRICIA CINNAMOMEA (Jacq.) Murrill, Bull. Torrey Club 31: 343. 1904.
Boletus cinnamomeus Jacq. Coll. 1: 116. 1786.
Reported by Børgesen and Paulsen under the name of *Polyporus oblectans* Berk., which is now regarded as a synonym of the above.

CORIOLUS NIGROMARGINATUS (Schw.) Murrill, Bull. Torrey Club 32: 649. 1906.
Boletus nigromarginatus Schw. Schr. Nat. Ges. Leipzig 1: 98. 1822.
Reported by Børgesen and Paulsen l.c. under the name of *Polyporus hirtellus,* which is now regarded as a synonym of the above.

Coriolus pavonius (Hook.) Murrill, N. Am. Fl. 9: 25. 1907.
Boletus pavonius Hook. in Kunth. Syn. Pl. 1: 10. 1822.
On wood. Collected near St. Thomas.

* CORIOLUS PINSITUS (Fries) Pat. Tax. Hymén. 94. 1900.
Polyporus pinsitus Fries, Elench. Fung. 95. 1888.
On stick. Collected near St. Thomas.

Coriolopsis rigida (Berk. & Mont.) Murrill, N. Am. Fl. 9: 75. 1908.
Trametes rigida Berk. & Mont. Ann. Sci. Nat. III. 11: 240. 1849.
On wood. Collected in hills near St. Thomas.

Elfvingiella fasciata (Sw.) Murrill, Trop. Poly. 90. 1915.
Boletus fasciatus Sw. Prodr. 149. 1788.
On wood. Collected in the vicinity of St. Peter.

Favolus Rhipidium Berk. in Hooker's Jour. Bot. 6: 319. 1847.
On wood. Collected in the vicinity of St. Peter.

Gloeophyllum striatum (Sw.) Murrill, Bull. Torrey Club 32: 370. 1905.
Agaricus striatus Sw. Prodr. 148. 1788.
On wood. Collected near John Bruce Bay.

GALERULA MACROMASTES (Fries) Murrill, N. Am. Fl. 10: 169. 1917.
Agaricus macromastes Fries, Nova Acta Soc. Sci. Upsal. III. 1: 226. 1855.
Known only from St. Thomas.

Hapalopilus gilvus (Schw.) Murrill, Bull. Torrey Club 31: 418. 1904.
Boletus gilvus Schw. Schr. Nat. Ges. Leipzig 1: 96. 1822.
On wood. Collected in the vicinity of St. Peter.

* LENTINUS CRINITUS (L.) Fries, Syst. Orbis. Veg. 77. 1825.
Agaricus crinitus L. Sp. Pl. ed. 2. 1644. 1763.
On wood. Collected in the vicinity of St. Peter.
Panus Troglodytes Fries, described from St. Thomas, is thought by Murrill to be close to the above species.

* LENTINUS HIRTUS (Fries) Murrill, Mycologia 3: 29. 1911.
Agaricus hirtus Fries, Linnaea 5: 508. 1830.
On wood. Collected near St. Thomas.
Lentinus flaccidus Fries, described from St. Thomas, is thought by Murrill to be a form of *L. hirtus*.

Lentinus velutinus Fries, Linnaea 5: 510. 1830.
On wood. Collected near Mandal.

MELANOLEUCA DICHROPUS (Fries) Murrill, Mycologia 3: 193. 1911.
Agaricus dichropus Fries, Nova Acta Soc. Sci. Upsal. III. 1: 22. 1855.
Known only from St. Thomas.

NAUCORIA PAPULARIS (Fries) Sacc. Syll. Fung. 5: 856. 1887.
Agaricus papularis Fries, Nova Acta Soc. Sci. Upsal. III. 1: 225. 1855.
Known only from St. Thomas.

Pogonomyces hydnoides (Sw.) Murrill, Bull. Torrey Club 31: 609. 1904.
Boletus hydnoides Sw. Prodr. 149. 1788.
On wood. Collected in several localities near St. Thomas.

Polyporus subelegans Murrill, N. Am. Fl. 9: 62. 1907.
On wood. Collected in the vicinity of St. Peter.

* PYCNOPORUS SANGUINEUS (L.) Murrill, Bull. Torrey Club 31: 421. 1904.
Boletus sanguineus L. Sp. Pl. ed. 2. 1646. 1763.
On wood. Collected in the vicinity of St. Thomas.

PILOSACE TRICHOLEPIS (Fries) Sacc. Syll. Fung. 5: 1010. 1887.
Agaricus tricholepis Fries, Nova Acta Soc. Sci. Upsal. III. 1: 25. 1855.
Said by Fries to have been collected in St. Thomas, but Oersted's drawing (according to Murrill) bears the name St. Croix.

* SCHIZOPHYLLUM ALNEUM (L.) Schroet. Krypt.-Fl. Schles. 3: 553. 1889.
Agaricus alneus L. Sp. Pl. ed. 2. 1644. 1763.
On sticks. Collected near St. Thomas.
Previously reported under the names *Schizophyllum commune* and *Schizophyllum multifidum,* both of which are regarded as synonyms of the above.

LYCOPERDALES

Cyathus triplex Lloyd, The Nidulariaceae 23. 1906.
On sticks. Collected in the vicinity of St. Peter.

Geaster Hariotii Lloyd, Myc. Notes 25: 311. 1907.
On soil in woods. Collected in St. Peter's Gut.
A beautiful species, with sulcate mouth. Determined by Dr. W. C. Coker.

DOUBTFUL SPECIES REPORTED BY BØRGESEN AND PAULSEN

Polyporus lucidus (Leys.) Fries. Probably some species of *Ganoderma,* but not *lucidus.*

Polyporus velutinus Fries. Probably some species of *Coriolus,* but not *velutinus.*

Polyporus incrustatus Fries. This is a doubtful species of *Ganoderma* originally reported from Costa Rica.

Polyporus fornicatus Fries. Some species of *Ganoderma,* but not *fornicatus.*

DOUBTFUL SPECIES REPORTED BY FRIES

Lentinus cochleatus Fries. This is now regarded as a synonym of *Lentinellus cornucopioides* (Bolt.) Murrill, which is not thought to occur in St. Thomas.

Panaeolus phalenarum (Fries) Quél. Murrill thinks this has been confused with *Campanularius solidipes* (Peck) Murrill, which occurs in St. Thomas.

NEW YORK BOTANICAL GARDEN

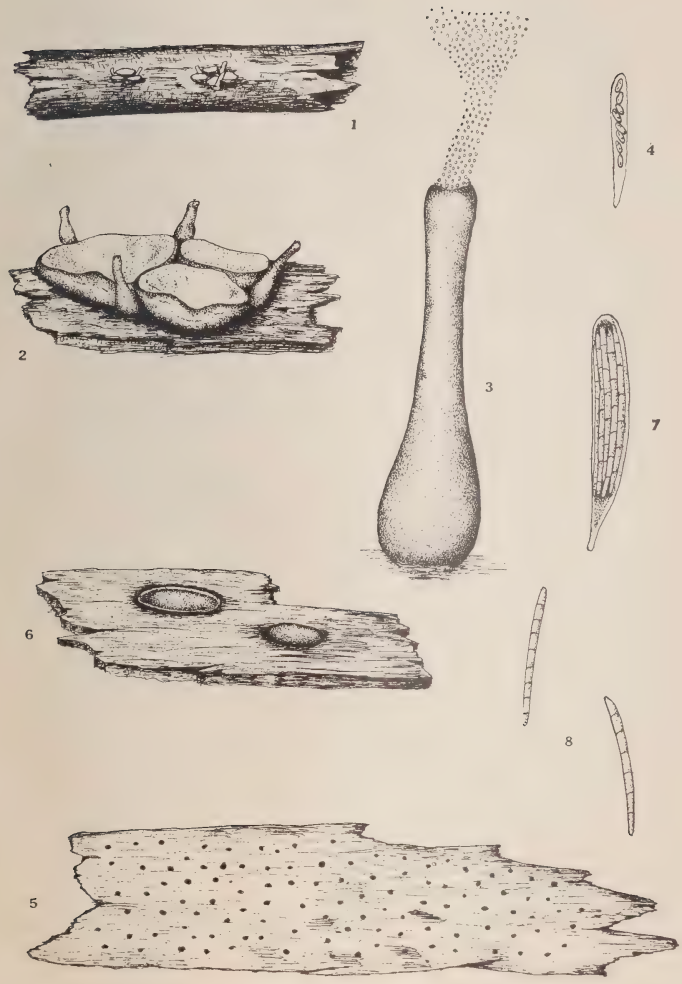
EXPLANATION OF PLATES

PLATE 1 (Frontispiece)

Island and town of St. Thomas from across the harbor.

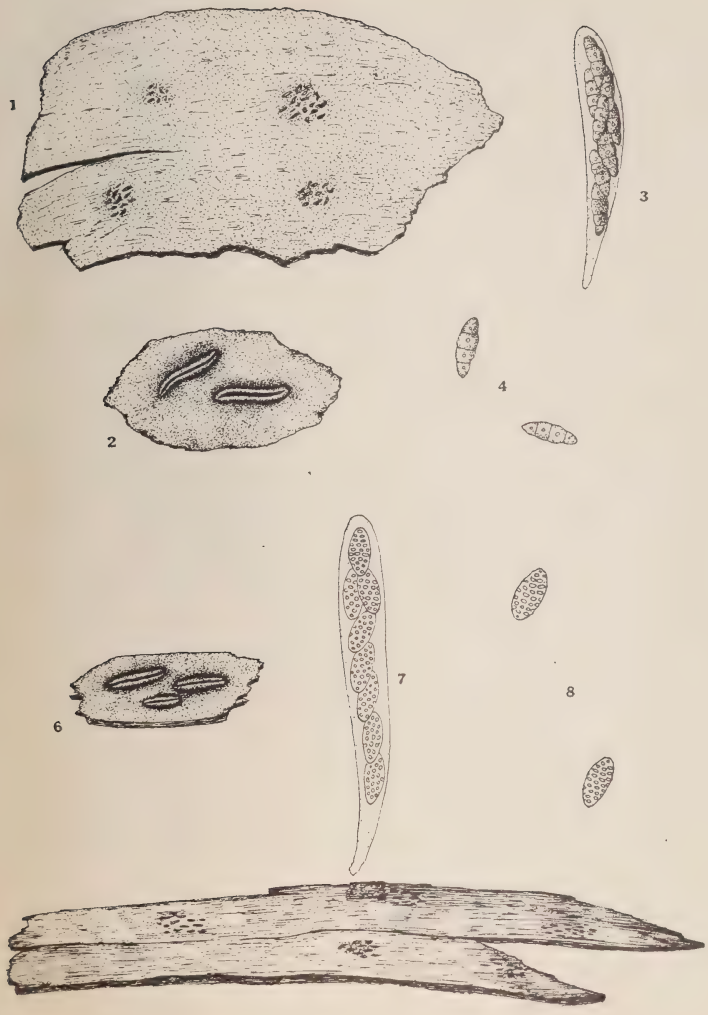
PLATE 2

Figs. 1–4. *Dermatea dimorpha.* 1, habitat, about natural size; 2, apothecia and pycnidia enlarged; 3, a single pycnidium and pycnospores much enlarged; 4, ascus with spores, drawn with the aid of the camera lucida.



1–4. DERMATEA DIMORPHA Seaver

5–8. BACTROSPORA INTEGRISPORA Seaver



1–4. HYSTERIUM CALABASH Seaver
5–8. GLONIOPSIS GUTTULATA Seaver

Figs. 5–8. *Bactrospora integrispora.* 5, habitat, about natural size; 6, two plants enlarged; 7, 8, ascus and spores, drawn with the aid of the camera lucida.

PLATE 3

Figs. 1–4. *Hysterium Calabash.* 1, habitat, about natural size; 2, two plants enlarged; 3, 4, ascus and spores, drawn with the aid of the camera lucida.

Figs. 5–8. *Gloniopsis guttulata.* 5, habitat, about natural size; 6, three plants enlarged; 7, 8, ascus and spores, drawn with the aid of the camera lucida.

NOTES ON SPECIES OF RUSSULA

Gertrude S. Burlingham

(With Plates 4 and 5)

During August, 1920, it was my good fortune to be invited to spend two weeks collecting at Indian Point, Magnetawan, Canada, the summer home of Dr. Howard A. Kelly. For the most part the species of *Russula* found were the same as found in the vicinity of Newfane, Vermont. *Russula lepida* Fr., however, was more common, and I found one undescribed species which I am pleased to name in honor of Doctor Kelly because of his active interest in mycology. Specimens of the species of *Russula* and *Lactaria* which I collected at Indian Point and vicinity are preserved in Dr. Kelly's herbarium and some duplicates are in my own herbarium.

When Dr. Peck described *Russula ventricosipes* from material sent him by Mr. Simon Davis he did not include the spore color or the taste. Miss Ann Hibbard has collected the species twice on Cape Cod, and in her notes on the specimens collected at North Eastham on October 15, 1920, the taste is given as mild and the spores described as deep cream-white in mass (fleshy-white, t. 4). In examining the spores I found them to be practically smooth as far as one could determine with an oil immersion lens and much longer in proportion to width than is usual with the *Russula* spores. But on examination of spores from the type, I found them identical with the spores from Miss Hibbard's specimens. The size varies from 5–6.25 μ x 8–10 μ.

Mr. Simon Davis has spent part of several summers in Wyoming and has sent me some excellent collections of both *Russulae* and *Lactariae* from that region. I shall reserve these for a special article on Wyoming species except for the one *Russula* which is described here.

The vicinity surrounding Newfane, Vermont, seems to abound with species of *Russula.* Although I have been collecting in the Newfane Hill region since 1914, I can find each summer a few

species which I have not seen before. The early spring in 1921 brought out in August species which usually do not appear until September and which possibly in short seasons do not appear at all. *Russula dura* was found in a spot where I have collected for seven years. On the other hand, *Russula secreta* has been found in small quantities since 1914, but not until 1920 did I find it in sufficient quantities to determine definitely the taste and spore color. In August, 1921, I found another solitary specimen of *Russula redolens* perhaps 1,000 feet distant from the type locality.

In Montgomery, Alabama, Dr. R. P. Burke is doing extensive collecting. Among specimens which he has sent me is *Russula Davisii,* described originally from Massachusetts, and *Russula magnifica* Peck, which have not been previously reported from the state. Three of the species seem to be undescribed. Dr. Burke has water-color sketches of these, and the type specimens are divided between my herbarium and the New York Botanical Garden herbarium.

Russula Kellyi sp. nov.

Pileus broadly convex, becoming expanded, up to 11 cm. broad; surface varying from chamois (325, t. 1–4) and brown pink (297), paler toward the margin, glabrous, very viscid when wet, pellicle separable half way to the center, margin striate-tuberculate; context peppery, without special odor; lamellae almost white, equal, a few forking next stipe, interveined, rounded at the outer end, narrowed then rounded at the inner end, broad, subclose; stipe white, not changing color when fresh, but slightly gray when dried, firm, stuffed, glabrous, 8 cm. long by 1.8 to 2 cm. thick, slightly ventricose; spores maize-yellow, tone 3, ellipsoid, echinulate, apiculate and unsymmetrical, 6.25 x 7.5 μ.

TYPE LOCALITY: Indian Point, Magnetawan, Canada, August 21, 1920.

HABITAT: On ground by decayed wood, in mixed pine and oak woods.

In dry weather the pileus is shining as though varnished, while in wet weather it is covered with a thick layer of viscidity. The color of a specimen collected in dry weather was brownish-terra-cotta (322, t. 1–2) on the outer portion and blood-red-brown in the center (337). From *Russula aurantialutea* Kauff. it may be

distinguished by the pale-gray color of the stipe when dried, and by the absence of any bright-yellow or orange color in the pileus of the fresh plant. In dried specimens there is also a slight-gray color seen in the depths of the lamellae. The spores are paler than those of *Russula aurantialutea.*

Russula alcalinicola sp. nov.

Pileus becoming expanded, umbilicate, up to 10 cm. broad; surface white, glabrous, viscid when wet, with pellicle separable part way to the center, margin wavy, substriatulate; context white, mild, fragile, without special odor; lamellae white, equal, rarely one forked, adnate, close, rather broad, even on the margin, pruinose; stipe white, discoloring slightly upon handling, attenuate downward, stuffed, becoming hollow, up to 3.5 cm. long and 3 cm. in diameter; spores pitchpin (310, t. 3), broadly ellipsoid, apiculate, coarsely echinulate, 8.75–10 x 6.2–7.5 μ in diameter.

TYPE LOCALITY: Rock Creek, Z/T Ranch, Wyoming.

HABITAT: Under greasewood, July 20, 1920.

In dried specimens the color of the entire specimen is chamois varying from tone 1 to 3 (325). The specimens were collected by Mr. Simon Davis and he describes the habitat as follows: "The elevation was between 6,700 and 6,800 ft. Most of them were found on the south bank of Rock Creek under a thick, almost impenetrable growth of greasewood in black humus, frequently wet from the numerous showers that prevailed during June 28 to Aug. 15. The white ones were persistently white."

The species may be distinguished by the white color throughout, the mild taste, and the yellow spores. It differs from *R. basifurcata* Pk. in its simple lamellae, persistently mild taste, and white color.

Russula operta sp. nov.

Pileus convex with margin bent in to the stem, becoming plane to slightly depressed, 2.5 to 4 cm. broad, surface old-blood-red to Morocco-red in the center, to coppery-old-rose, salmon, or reddish-salmon on the margin, pruinose, viscid when wet, with separable pellicle, margin becoming striate-tuberculate; context white, reddish next the pellicle, slowly peppery, without special odor; lamellae white at first then maize-yellow, tone 1, equal, mostly simple, if forking, then close to stipe, round and broad at the outer end, narrowed at the inner and occasionally sinuate, interveined, rather

close; stipe white, rarely with a tinge of pink at the apex, pruinose above, nearly equal, stuffed becoming hollow, slender, 2–2.5 cm. long; spores pale-écru (66, t. 2), broadly ellipsoid, apiculate, unsymmetrical at the base, very coarsely and distinctly echinulate, uniguttulate, or rarely diguttulate, 6.3–7.5 μ x 7.5–7.8 μ exclusive of apiculus, which is 1.25 μ long.

TYPE LOCALITY: Newfane Hill, Newfane, Vermont.

HABITAT: In a wood road under beech, or under yellow birch with hemlocks near. August 30, 1920, and August 22, 1921.

DISTRIBUTION: In several localities on Newfane Hill.

This species resembles *Russula pusilla* Peck, but differs in the taste and in the markings of the spores. The stipe is also usually longer than that of *Russula pusilla*. The acridity seems to be located in the pileus and becomes very evident when one chews the entire pileus. In old specimens the taste may be nearly mild. It is a very pretty little species, but because of its small size it often escapes discovery.

Russula dura sp. nov.

Pileus convex, becoming plane to centrally depressed, up to 8 cm. broad; surface yellow-ocher to brownish-terra-cotta with some burnt-umber toward the center, unevenly colored, pruinose, cuticle adnate, margin even; context sweetish then bitter and disagreeable, somewhat as horse urine smells, leaving a cool sensation, without special odor, hard and compact; lamellae white then fleshy-white, becoming ocher-yellow on the edge for about 1 cm. from the margin of the pileus, equal, a few forking close to the stipe, broad, rounded at the outer end and narrowed at the inner; stipe white, washed on one side with hazel, somewhat pruinose, becoming larger below the middle, then abruptly contracted at the base, with longitudinal wrinkles, firm, up to 5 cm. long and 1.5 to 2 cm. thick; spores white, subglobose, tuberculate, apiculate, symmetrical in one view and unsymmetrical in another, a few uniguttulate.

TYPE LOCALITY: Newfane Hill, Vermont, August 22, 1921.

HABITAT: In needle soil or among leaves under beech and hemlock.

This species seems very distinct from other species in appearance, firmness, and taste. Although five specimens in different stages of maturity were found, it was not possible to obtain a mass of spores in a print, but on the lamellae they were white. The pruinose bloom remains on the pileus even when dried.

Russula subtilis sp. nov.

Pileus broadly convex, becoming plane to centrally depressed, up to 4 cm. broad; surface slate-violet or with a faint wash of salmon-lilac, darker toward the center, pruinose, granulose toward the margin when viewed with a lens, viscid when wet, cuticle separable, margin even; context mild, then imparting a stinging sensation to the throat; lamellae white, equal, rounded at the outer and narrowed at the inner ends, subdistant, broad; stipe washed with Corinthian-red, equal or tapering downward, pruinose, especially at the apex, which is white-stuffed, 3 cm. by 1.5 cm.; spores white, somewhat ovoid to broadly ellipsoid, apiculate, unsymmetrical in one view, minutely echinulate, 7.5 x 10 μ, including the apiculus, which is 1 μ long.

TYPE LOCALITY: Newfane Hill, Vermont.

HABITAT: In wood road in beech, birch, and hemlock woods, August.

DISTRIBUTION: In two localities in the same woods, Newfane Hill, Vermont.

This species is quite different in appearance from any other nearly mild, lilac, white-spored species. It is more fragile than *Russula corallina* Burl., and the lamellae are more distant and remain nearly white in drying, while the gills of *R. corallina* become yellow. The latter species differs in color also.

Russula fucosa sp. nov.

Pileus broadly convex, becoming plane to centrally depressed, up to 5 cm. broad, surface old-blood-red (103) to coppery-red (108) or peach-red (98) to garnet-brown (164, t. 1) when mature, with some maize-yellow t. 2 in the center or elsewhere, very pruinose, viscid when wet, cuticle separable as far as the disk, margin even to faintly striate-tuberculate in places; context mild and sweet, white, staining snuff brown to putty color, developing an odor in drying slightly like that of *R. atropurpurea* Pk.; lamellae nearly white, equal, a few forking next the stipe, broad, narrow at the inner end, close, adnate, appearing free in age; stipe white or with a trace of pink, staining a little snuff brown where handled, glabrous, 3–4 x 1–1.5 cm.; spores flesh color (67, t. 2), nearly globose, very echinulate, 8.75 x 8.75 μ exclusive of the apiculus which is 1.87 μ long, the spines being 1 μ long.

TYPE LOCALITY: Newfane Hill, Vermont.

HABITAT: In moist woods of beech and spruce.

DISTRIBUTION: Newfane Hill, Wardsboro, and Londonderry, Vermont; Richmond, Staten Island, and Stow, Mass. (No. 1 of Aug. 22, 1916, Simon Davis).

This is a very beautiful species. The flesh does not become as sordid as that of *Russula atropurpurea* Pk., the odor is never very strong, and the spores are much paler. In color, the species resembles *Russula pulchra* Burl., but differs in the changing flesh, and the slight odor which develops in drying. The spores of *Russula pulchra* are nearer white. The first collection of which I have record is the one from Wardsboro in 1910. Since 1917 I have found it nearly every year on Newfane Hill. The type is based on specimens collected on Newfane Hill in 1922.

Russula Burkei sp. nov.

Pileus convex, becoming expanded with depressed, subumbilicate center, 5.5 to 7 cm. broad; surface madder-brown on the disk, shading outwards to tawny-olive, and occasionally clay-colored spots, the colors being somewhat intermingled over the central portion, viscid with pellicle separable part way to the center, glabrous, margin even, sometimes broadly undulate; context very compact and firm, white to smoky, becoming slowly vinaceous-drab where cut, slowly very acrid, odor somewhat like *Russula foetens;* lamellae white, not stained with spots, yellow in drying, equal, few or none forking, narrowed behind, rounded in front, crowded; stipe white becoming blackish-gray internally with age and somewhat discolored externally where bruised, slightly ridged, stuffed but not fragile, 4 cm. long, 1.8 cm. thick; spores pale-écru (66, t. 1), nearly globose, very minutely tuberculate, apiculate, 6.25–7.5 x 7–8.75 μ.

TYPE LOCALITY: Montgomery, Alabama.

HABITAT: Mixed woods. Type collected by Dr. R. P. Burke, July 23, 1921.

This species resembles *Russula obscura,* and *Russula rubescens* and *Russula cinerascens* in the change in the color of the flesh. It differs in its acrid taste and disagreeable odor from *Russula cinerascens,* in color, in taste, and in the spore markings from the others. In the dried state the pileus is brownish drab (302), except in the center, where it is nearly black. The lamellae in dried

specimens are isabelline (309, t. 4). The flesh of the pileus shows blackish between the bases of the lamellae. The description has been arranged from notes made by Dr. Burke, and the colors of the fresh mushroom are named according to Ridgeway.

Russula affinis sp. nov.

Pileus broadly convex, then expanded and depressed in the center, about 6 cm. broad; surface vinaceous-fawn, fawn to army-brown in the center, periphery and middle zone smoke-gray to light-grayish-olive, or middle zone occasionally dingy-buff, slightly viscid in the center when wet, with pellicle separable half way to the center, glabrous in central portion, minutely gray-scurfy to suppressed-squamulose under the lens over the outer half, margin faintly tuberculate-striate; context white, acrid, without characteristic odor; lamellae pale-creamy-white, rust stained where bruised, close, equal, a few forking near stipe, rounded in front, tapering behind, adnexed, edges even; stipe pure-white, dingy-brown in grub holes, and all over in drying, tapering downwards, stuffed to hollow, glabrous, fragile, 3 cm. long by 12 mm. at the apex and 8 mm. at the base; spores fleshy-white (9, t. 4), broadly ellipsoid, minutely echinulate, apiculate, unsymmetrical, 6.25 x 7.5 μ, cystidia awl-shaped, granular, scattered.

TYPE LOCALITY: Montgomery, Alabama, Court St. woods, July 22, 1921.

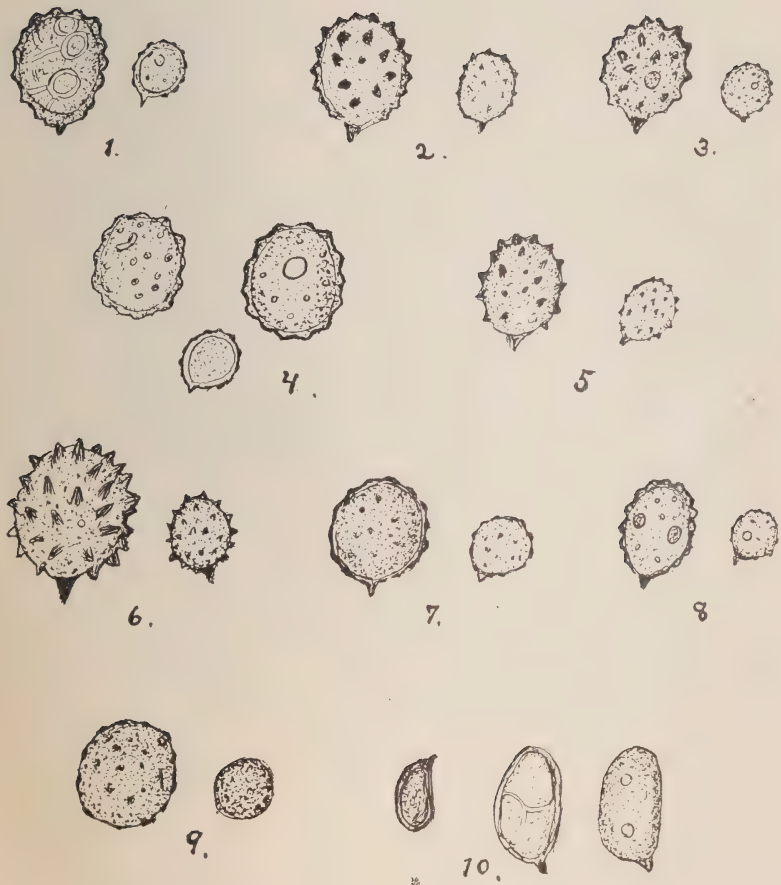
HABITAT: Under oak trees, gregarious.

This seems to be near *Russula granulata* Pk., but may be readily distinguished by its more smoky-brown colors, its less striate margin, its less noticeable granules on the surface of the pileus, and its more echinulate spores. The striations extend in for only one half centimeter, and are scarcely discernible in the dried specimens. In dried specimens the stipe and lamellae are raw umber.

Russula chlorinosma sp. nov.

Pileus becoming expanded, centrally depressed, with incurved margin, up to 11 cm. wide; surface cream-colored to white, not viscid, glabrous to minutely or coarsely rimulose or areolate, forming appressed squamules which are sometimes Buckthorn-brown, margin even or striate only at the extreme edge, incurved; context white to pallid, unchanging, fairly firm, mild, but slightly disagreeable, odor disagreeable, suggesting chlorine; lamellae white to

1. RUSSULA DURA Burlingham
2. RUSSULA OPERTA Burlingham



SPORES OF RUSSULA

Massicot-yellow in side view, cream-buff in edge view, a few unequal, many forking at and near the stipe, rounded at the outer end, narrowly rounded and adnexed to almost free at the inner end, close, edge even; stipe concolorous to white, not changing color where handled or bruised, minutely pruinose at the apex, even, soft, stuffed, 2 cm. thick at the apex, 2.5 cm. thick below, somewhat ventricose, up to 9 cm. long; spores with faint tinge of cream color, nearly smooth, under the oil immersion appearing granular or minutely tuberculate, 6.25 x 7.5 μ.

TYPE LOCALITY: Montgomery, Alabama, July 31, 1921, Dr. R. P. Burke.

HABITAT: On the ground in mixed woods, fairly shady.

Dr. Burke writes regarding this species: "It is very common in South Court Street woods and gives the whole woods a chlorine odor, very disagreeable. It is too disagreeable to be kept in one's home in the dried state. The spore mass is almost white, but has a faint tinge of cream—between Ivory yellow and white (Ridg.)."

In the dried specimens the surface of the pileus reminds one of the crustose appearance of *Russula crustosa*. The odor persists up to the present time, nearly one year after collection.

556 LAFAYETTE AVE.,
BROOKLYN, N. Y.

EXPLANATION OF PLATES

PLATE 4

Fig. 1. *Russula dura.*
Fig. 2. *Russula operta.*

PLATE 5

Fig. 1. *R. Kellyi.*
Fig. 2. *R. alcalinicola.*
Fig. 3. *R. operta.*
Fig. 4. *R. dura.*
Fig. 5. *R. subtilis.*
Fig. 6. *R. fucosa.*
Fig. 7. *R. Burkei.*
Fig. 8. *R. affinis.*
Fig. 9. *R. chlorinosma.*
Fig. 10. *R. ventricosipes.*

STUDIES ON PLANT CANCERS—VI*

FURTHER STUDIES ON THE BEHAVIOR OF CROWN GALL ON THE RUBBER PLANT, FICUS ELASTICA

MICHAEL LEVINE

(WITH PLATE 6)

In a study of the effect of crown gall on the rubber plant, *Ficus elastica* (Levine, 1921), it was shown that one of two types of crown gall may result when the internode of a young growing branch is inoculated with *Bacterium tumefaciens*. These are either benign or malignant in nature. The benign type is relatively short-lived, grows to a considerable size, becomes differentiated, and dies. It eventually drops out, leaving a scar, which in no way affects the further growth and development of the stem. The malignant type of crown gall is characterized by a localized growth which also becomes differentiated, forming a mass of parenchymatous cells with nodules of woody fibers. The conducting system of the stem is but partially invaded by the crown-gall tissue, yet the part of the branch above the gall dies as well as a part of the stem below. The death of the branch due to crown gall is at least suggestive of the death caused by malignant growths in animals.

The plants which were reported on, together with ten additional plants of the same age and size and inoculated with *Bacterium tumefaciens,* have been carefully studied since the first record was made. The subsequent observations made, it is believed, are of sufficient interest to warrant a further brief report.

CROWN GALL ON OLD STEMS OF FICUS ELASTICA

It has been stated by animal and plant pathologists that young animal and plant tissues respond to stimuli producing neoplastic growth much better than do older living things. While this is true for the rubber plant, it appears that older parts of the plant, such

* From the Cancer Division, Montefiore Hospital, Dr. Isaac Levin, Chief.

as the bark-covered portions of the main stem and older branches, respond very rapidly to inoculations of *Bacterium tumefaciens*. Figure 1 represents the results of an inoculation of a tree 8 feet tall, having a diameter of approximately two inches, with an emulsion of *Bacterium tumefaciens*. Small and isolated nodules of hyperplastic tissue appeared from 2 to 3 months later in each inoculated opening made by the needle. These grew rapidly and became confluent, as shown in the photograph taken 3 years after the inoculations were made. The crown galls became differentiated and formed a woody structure which could easily be removed from the tree by the application of slight lateral pressure. On examination, the parts removed were dead, dark-brown in color, and of a corky consistency. The part of the gall remaining was active and exuded the characteristic latex of the rubber plant. Subsequent growth resulted in the development of a larger crown gall on the part where the dead portion was removed, and at the end of the season the necrotization of the new growth formed a deep wound in the stem, as shown in the dark area to the right in the photograph. The globular crown galls seen to the left are new growths of the third year.

These observations are in complete accord with those of Toumey (1900) described for the spontaneous overgrowths occurring in the almond.

Figure 2 represents an enlargement of the branch illustrated in figure 3, showing a crown gall artificially induced by inoculating an old, bark-covered branch (figure 3, arrow) with *Bacterium tumefaciens*. The growth is 3 years old, and is quite active. The central portion, indicated by the arrow, is new growth, rather smooth, and made up of living tissue from which a latex is obtained on injury. To the left of the area are the remnants of the growth of the previous years. The health of the branch has not been affected, as can be seen by the abundant foliage. Crown gall is not a dangerous disease, at least when induced experimentally, in the rubber plant. The figures mentioned above represent a series of six such experiments. While no plant has been killed, it is reasonable to assume that if growth proceeds as already begun, it is but a matter of time before the stem will be weakened by the suc-

cessive necrotization of the crown-gall tissue, so that there will be no resistance offered to the effects of winds. Studies of crown galls on the apple to be reported later, resulting from inoculations of *Bacterium tumefaciens* into the stems, behave similarly and my observations confirm the results of Hedgcock's (1910) findings in his field studies on this plant.

CROWN GALLS ON TERMINAL PARTS OF YOUNG BRANCHES

It has been shown by my earlier studies of the crown gall on the terminal or green parts of the branch of a rubber plant that the neoplastic growth resulting from an inoculation of an axillary bud or internode of the stem grows rapidly, and in the course of a year dies. As mentioned above, the parts of the branch above the crown gall and for a distance below died also. While the phenomenon may be attributed to the effects of the crowngall cells or the bacterium, the further study of the branch below the necrotized part of the stem below the crown gall is very interesting, and suggests that the bud stimulation, which Smith (1916) refers to as a " pathological phenomenon," is in reality an effect which operates in a way comparable to decapitation without the removal of the parts. The growths which appear on these stems are suggestive of the stimulus that operates in producing axillary crown galls, such as appear in the rubber (Levine, 1921—figs. 8–10), and the aberrant types of axillary crown galls, such as I described for the tobacco plant (1923).

Figure 4 represents a tree of *Ficus elastica* which had been inoculated with *Bacterium tumefaciens* 2 years and 5 months previous to the time the photograph was taken. The dark mass of tissue to the upper left in the photograph represents the crown gall with the necrotized tip of the branch. Shortly after the necrosis of the crown gall and stem occurs it is noted that one of the buds nearest the necrotic stem-tissue begins to sprout into a short branch from which a single leaf develops in less than 6 months. This branch grows rapidly and a large number of normal leaves are developed as shown in the photograph. The orientation of the branch appears aberrant and now, approximately three years after its development, a normal negative geotropic reaction is becoming visible.

Another plant from which the wind broke the major part of the necrotized apical portion of the stem with its crown gall is shown in figure 5. The dead part of the branch appears in the center of the picture. An apical internode was inoculated 3 years previously. The crown gall developed in the usual manner. The necrosis of the crown gall and parts of the branch was followed by the development of a number of buds which, however, formed a number of small branches, each bearing two to three leaves. These are normal in appearance and apparently in function. Several plants showed this production of stems with leaves after the crown gall and the parts of the branch above and below the crown gall had died.

A third series of cases shown in figure 6, somewhat more complicated than the previous two, was observed after necrosis of the branch with its crown gall had resulted. The growth shown in the picture is 2½ years since the inoculation was made. A bud developed shortly after the death of the crown gall and parts of the stem above and below the crown gall took place. It grew rapidly into a branch (shown by the arrow) with a normal number of leaves similar to the one shown in figure 4. The orientation of the shoot is, however, aberrant in this case, as is the one cited in the first instance. The other interesting fact is that the buds below the necrotized parts of the branch become active for a considerable distance down the stem, and in figure 7, a stage 2 months later than the one shown in figure 6, we find that a number of young branches have developed.

The appearance of these branches on the upper part of the stem only seems to be abnormal. However, comparisons of this growth were made with decapitated branches shown in figures 8 and 9. The horizontal branch shown in figure 8 was decapitated 6 months previously. The low temperature at first interfered with its growth somewhat, but for the last 3 months before the photograph was made the rate of growth was rapid, and, while as many as ten buds along the stem appear to have been stimulated, only one grew into a small branch, of which two leaves are beginning to unfurl.

In figure 9 a much older branch was decapitated a year previous to the time of the taking of the photograph. While a considerable

number of dormant buds were stimulated to develop, the positions of the stimulated buds are confined more to the side of the branch away from the camera, and the appearance is therefore not unlike the bud development shown in figure 7.

An analysis of the material shows that a crown gall produced on the apical part of a branch of *Ficus elastica* necrotizes, and with it die the parts of the branch above and below the gall. The nearest axillary bud of the part of the stem below this necrotized area sprouts out and produces a small branch. This is followed some time later by the budding-out of a number of dormant axillary buds along the length of the branch, not unlike the budding-out of the dormant buds of similar branches which are decapitated.

This suggests that the development of buds after inoculation with *Bacterium tumefaciens* into the axillary leaf buds of a stem is due to a localized stimulation of a mechanical nature rather than a pathological one. Further, the necrotizing area acts as a mechanical stimulus in a measure comparable to decapitation; the complete stimulating effect of decapitation possibly being inhibited by the effects of the crowngall cells or the bacteria. When complete necrosis of the crown gall and adjacent parts of the stem occur, the living parts of the stem function as does a decapitated branch and the dormant buds develop.

This suggests further that all the axillary-bud-crown-gall formations are not of a pathological origin, but develop as a result of a mechanical stimulus similar to decapitation.

SUMMARY

1. Further studies on the effect of crown gall on *Ficus elastica* show that buds below the necrotized crown gall and stem developed into branches and leaves.

2. The regularity of the development of the dormant buds suggests that axillary buds developed when inoculated with the crowngall organism are not due to the effect of bacteria, but to a localized mechanical stimulation similar to decapitation.

3. The complete stimulative effect is inhibited by crown gall and only when complete necrosis of the crown gall and adjacent parts occurs is the mechanical stimulus allowed to act.

CROWN GALL ON FICUS ELASTICA

LITERATURE CITED

1910. **Hedgcock, G. C.** Field studies of the crown gall and hairy root of the apple tree. U. S. Dept. Agric. Bur. Pl. Ind. Bull. 186: 1–108. *pl. 1–10.*

1921. **Levine, Michael.** Studies on plant cancers—II. The behavior of crown gall on the rubber plant (*Ficus elastica*). Mycologia 13: 1–11. *pl. 1.*

1923. —— Studies on plant cancers—V. Leafy crown galls on tobacco plants resulting from *Bacterium tumefaciens* inoculation. Phytopath. 13: 107–116. *pl. 5–7.*

1916. **Smith, E. F.** Crown gall studies showing changes in plant structures due to changed stimulus. Jour. Agr. Res. 6: 179–182. *pl. 18–23.*

1900. **Toumey, J. W.** An inquiry into the cause and nature of crown galls. Bull. Arizona Agr. Exp. Sta. 33: 7–64. *f. 1–31.*

EXPLANATION OF PLATE 6

Fig. 1. Main stem of rubber plant, *Ficus elastica,* inoculated with *Bacterium tumefaciens,* showing old necrotized area to the right and new small galls 3 years after inoculation.

Fig. 2. Smaller branch showing new growth in center following the death of the crown gall of the previous years.

Fig. 3. Shows position of crown gall on stem shown in figure 2.

Fig. 4. Dead crown gall with apical portion of branch. The bud below the dead part developed into a branch with numerous leaves.

Fig. 5. Part of dead branch from which the dead crown gall and the tip of the branch are removed. The dormant buds below the necrotized parts developed into a number of small branches.

Figs. 6–7. Successive stages in development of dormant buds of a branch bearing a crown gall. Fig. 6, a branch similar to one shown in fig. 4 developed shortly after necrosis of the crown gall. The dead part of the branch above the crown gall was broken off.

Fig. 8. Normal young branch decapitated six months previously, showing irregular development of dormant axillary buds.

Fig. 9. An old normal branch decapitated, showing irregular distribution of developing axillary buds one year after decapitation.

MONTEFIORE HOSPITAL,
N. Y. CITY

A NEW HYSTERIUM FROM ILLINOIS

L. R. Tehon and P. A. Young

Most, if not all, of the known species of *Hysterium* are believed to be saprophytic. The attention they receive is small, for even the confirmed mycologist, with his studies directed toward parasitic fungi as an economic justification for his occupation, finds little time to devote to this kind of fungus.

However valid such an attitude may be, it is true that species of *Hysterium* and other fungi of a similar habit do have a useful rôle in the eventual return of plant parts to the soil from whence they came. In the unending evolution of plants from the soil, and the return to the earth of its own substance enriched and expanded through its change to organic material, the last great process falls to the lot of fungi and bacteria. Theirs is the task of reduction from conventional plant form to crumbled humus. What the whole process is must remain unknown for a long time, but occasional observations may add to our knowledge from time to time. The writers present this account with the intention of recording one more of the many species of fungi concerned in this task.

Of the species of *Hysterium* immediately available to us in exsiccati, all are bark inhabiting. *H. pulicare* Pers. with its several varieties is apparently limited to a bark habitat. Undoubtedly these fungi, whose characteristic habitat is the bark of dead or fallen trees, function in a real degree in the ultimate decay of the bark tissues of many of our forest trees.

On May 12, 1923, P. A. Young visited White Heath, in Piatt County, Illinois, for the purpose of collecting parasitic fungi. During his search he observed a fallen and nearly decomposed sycamore log, some of the bark of which was covered with the apothecia of an hysteriaceous fungus. This material was brought to our laboratory and subjected to microscopic examination in order to check up its agreement with a preliminary determination as *Hysterium pulicare* Pers. The examination, while demonstrating that the fungus was clearly a species of *Hysterium*, revealed

certain morphological discrepancies which lead the writers to believe that it can not be considered conspecific with any of the members of this genus so far described.

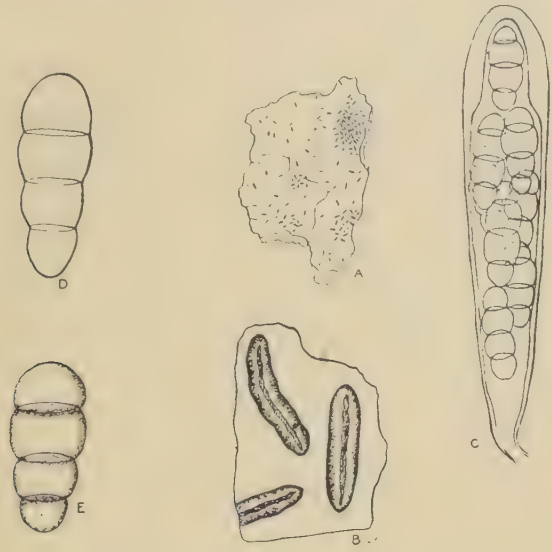


FIG. 1. *Hysterium pulcherrimum.*
A. Habitat sketch; *B.* Apothecia; *C.* Immature ascus; *D, E.* Spores.

Associated with the conception of the saprophytic character of these fungi, there has grown up a notion that the saprophytism is facultative rather than obligatory. If a facultative saprophytism is correctly ascribed to these fungi, its effect upon their morphological characters has not as yet been made clear. It appears to the writers, therefore, that there is no more satisfactory way of recording the present specimen than to give it specific rank.

Hysterium pulcherrimum sp. nov.

Apothecia irregularly disposed, densely gregarious or widely scattered, elongate, black, carbonaceous, rupturing longitudinally, 300–800 x 130–235 μ, 150 μ high, distinctly and neatly formed. Asci clavate, 40–70 x 10–12 μ, 8-spored. Spores mostly clavate, fuscous to olivaceous and uniformly colored throughout, mostly 3-septate, 11–18 x 4–7 μ. Paraphyses abundant, filiform, exceeding the asci in height, branching abundantly towards the apex, the branches coalescing to form a carbonaceous epithecium often 10–20 μ thick.

TYPE: On the bark of a fallen tree (*Platanus occidentalis* L.) at White Heath, Illinois, May 12, 1923. Collected by P. A. Young. Deposited in the herbarium of the Department of Botany, University of Illinois.

This species differs from *H. pulicare* Pers., with which it appears most closely allied, especially as regards spore size, those of Persoon's species measuring 27–33 x 8–10 μ. The macroscopic aspect is quite different, as well, when the two are compared, ours being much more clear-cut and neat in appearance, the apothecia more abundant and decidedly smaller. The gelatinization of immature asci and the thick carbonaceous epithecium are likewise characteristic. The characters of our species are shown in the accompanying drawings.

STATE NATURAL HISTORY SURVEY,
URBANA, ILL.

THE AECIAL STAGE OF PUCCINIA PATTERSONIANA

A. O. Garrett

On June 21, 1920, the writer collected in Parley's Canyon, at Gogorza, Summit Co., Utah, an aecium on *Brodiaea Douglasii* S. Wats. The plants of *Brodiaea* were growing on the side and at the bottom of an embankment running east and west, consequently they had more or less protection from the sun. These *Brodiaea* plants were all of the first year's growth, and the leaves had begun to wither. Supposing that the aecium was that of the well-known *Uromyces Brodiaeae* Ellis & Hark., a careful but unsuccessful search for telia was made on the withering and withered leaves.

Along the top of the embankment *Agropyron spicatum* (Pursh) Scrib. & Smith was growing, and on this grass uredinia were beginning to show. A specimen of the uredinia was sent to Dr. Arthur, and determined as those of *Puccinia Pattersoniana.*

From the abundance of the aecia on *Brodiaea,* the close proximity of the two host plants, the fact that the aecium was not followed by a later stage on the *Brodiaea,* and the further fact that *Elymus condensatus,* which abounds in the region, is always heavily infected by *Puccinia Pattersoniana,* the writer concluded that in all probability this aecium on *Brodiaea* is the alternate stage of *Puccinia Pattersoniana.*[1]

Acting on this suggestion, Dr. E. B. Mains conducted some correlation studies, in which he found that *Puccinia Pattersoniana* and the short-cycled *Puccinia Moreniana* on *Brodiaea capitata* Benth. have teliospores nearly identical in size, in thickness of the walls and with striking longitudinal striations. Moreover, the pedicels of the teliospores of both were stained dark blue by iodine. As a result of these studies, Dr. Mains concludes: "In the light of the observations of Dietel and Fischer and the work of Tranzschel, the striking resemblance between the teliospores of

[1] Garrett, A. O. Mycologia 13: 104, 110. 1921.

these two rusts strongly indicates that *Puccinia Pattersoniana* has its aecial stage on *Brodiaea.* This also, when taken with the field association noted by Prof. Garrett, can leave but little doubt as to the connection." [2]

In May and June, 1922, the writer found the aecia and the telia growing in close juxtaposition not only at Gogorza, but also at a number of other points, continuing at least eight and a half miles down the canyon. At the station eight and a half miles down the canyon, the close association of heavily rusted plants of *Elymus* and *Brodiaea* was very convincing of the connection of these two rusts. Rusted *Brodiaea* plants were also seen from Lamb's Canyon, a tributary of Parley's Canyon. Below Gogorza, however, the rusted *Brodiaea* plants were mature and flowering.

In March, 1923, a plant of *Elymus condensatus* was transplanted to a protected place in the writer's garden from a large clump growing not far from the East High School. This clump had been under observation for several years, and was known to be free from rust. On May 17, accompanied by Mr. L. A. Giddings of the East High School, whose hearty co-operation made the work possible, a trip was made to Parley's Canyon, where an abundant supply of the aecia on *Brodiaea* was secured. The *Elymus condensatus* in the garden, after being thoroughly sprayed, was inoculated with scrapings from the aecia on the *Brodiaea.* In addition, about a double handful of infected *Brodiaea* leaves were supported among the leaves of the *Elymus.* It began to rain at 7.45 P.M., within an hour after the inoculation was completed. During the night a trace of rain, or else a good shower, fell every hour, so that by morning a total of 0.62 inch had fallen. At 6 A.M. the following morning the temperature was 54°, and the relative humidity 78 per cent. As will be seen, these conditions were unusually favorable for outdoor inoculation work.

On May 30 uredinia were beginning to show on the *Elymus.* By June 7 the *Elymus* was heavily infected with uredinia, scarcely a leaf escaping, with telia beginning to make their appearance. On June 9 I collected forty leaves from the *Elymus,* many of them almost entirely covered with uredinia. Perhaps ten or fifteen infected leaves remain on the plant.

[2] Mains, E. B. Ind. Acad. Sci. **1921**: 133–135. 1922.

On June 8 the clump of plants from which the inoculated plant was taken was inspected for rust, but it was absolutely free. Moreover, there is no chance for the *Elymus* plant to have been infected from wind-borne spores from *Brodiaea,* as the nearest infected plants are twenty miles away.

The above experimental results remove all doubt that the aecial stage of *Puccinia Pattersoniana* is found on *Brodiaea.*

It seems to me that one point is emphasized by these results—that *any* aecium occurring abundantly associated with a telial form whose aecium is unknown should be looked on with suspicion, provided the aecium does not later develop the telium supposed to be associated with it.

EAST HIGH SCHOOL,
SALT LAKE CITY, UTAH

NOTES AND BRIEF ARTICLES

(Unsigned notes are by the editor)

Dr. O. A. Reinking has resigned from the University of the Philippine Islands and is now located in Honduras as plant pathologist for the United Fruit Company.

The stem-spot disease of the common rush, *Juncus effusus,* so extensively cultivated in Japan for the manufacture of mats is attributed by M. Kasai to the attacks of a fungus which he describes as *Cercosporina juncicola.*

According to Léon Azoulay, the color of the spores of gill-fungi may be obtained very quickly by passing paper, cloth, or a feather between the gills. In specimens having milky juice care must be taken to distinguish between the spores and the milk.

A provisional list of the parasitic fungi of the Philippine Islands prepared by C. G. Welles was published in the *Philippine Agricultural Review* for 1922. It includes 260 genera and 958 species of fungi, with hosts and a host index.

In *Phytopathology* for December, 1922, Lee Bonar describes a new hickory canker on *H. ovata* in Michigan caused by *Rosellinia caryae.* It attacks the twigs and trunks of young trees, causing dead, sunken areas; and in some cases the trees were entirely killed.

Three fine plants of *Agaricus rubribrunnescens* appeared in my lawn at Bronxwood Park on August 3, 1923, and were dried for the Garden herbarium. They grew under a red maple about two yards from the spot where I collected the type specimens on September 8, 1916.

Phytophthora cinnamoni has been described by R. D. Rands as the cause of a bark canker of cinnamon trees in the uplands of the

west coast of Sumatra, which is particularly destructive in badly drained plantations. Susceptible trees are usually killed by this disease and by insects within a year after attack, before they reach the most valuable age for harvesting.

A series of two or three papers on the Gastromycetes of North Carolina by Coker and Couch was begun in the *Journal of the Elisha Mitchell Scientific Society* for May, 1923. The first paper includes species of *Clathrus, Simblum, Mutinus, Ithyphallus,* and *Dictyophora,* all of which are abundantly illustrated with half-tone plates.

Dr. Weir reports in *Phytopathology* that *Polyporus Spraguei* causes a brown, friable rot in the heartwood of the trunk and roots of living oak and chestnut. Sections of chestnut trunks infected with the mycelium of this fungus developed hymenophores within a comparatively short time.

A brief report was made by N. L. Cutler in *Phytopathology* for June, 1923, on some of the tree-destroying fungi of the Vancouver forestry district; 24 species being considered important. Several hosts were recorded, but *Pseudotsuga taxifolia* and *Tsuga heterophylla* were attacked by far the largest number of fungi.

Microörganisms in the leather industries have been treated by F. A. Mason in a series of articles published in the *Bulletin of the Bureau of Bio-Technology,* London. In the genus *Penicillium,* for example, four species are found on leather, but only two, *P. decumbens* and *P. expansum,* are at all common.

Vermicularia zingibereae is the name proposed by S. Sundaraman for a new disease of ginger in the Godavari district of India. It appears on the leaves in circular, yellow spots, which enlarge, become discolored, and often die. Even the scaly leaves on the rhizomes are attacked in very severe cases.

Pear blight may now be controlled, according to H. S. Jackson, especially if the Kieffer and other resistant varieties are planted. A good solution for disinfecting the tools and the wounds made in removing affected branches is said to be 1 part of corrosive sublimate and 1 part of cyanide of mercury to 500 parts of water.

Bulletin No. 7, Part 2, of the *Natural History Survey* of the Chicago Academy of Sciences, by W. S. Moffatt, is an illustrated handbook of the Gastromycetes found in the region of Chicago. With the aid of this pamphlet, the collector should be able to trace most of the species of the group occurring in the district covered.

Very fine specimens of *Daedalea ambigua* were received on August 1 from Gainesville, Florida, collected on an oak log by Mr. G. F. Weber. These specimens were milk-white, with an ochraceous stain on the margin where bruised, and to some extent also on the hymenium where attacked by insects. The tubes were fine, small, and daedaleoid. The specimens were still fresh when received and had a faint but distinct odor of anise. The largest measured 13 inches in width, 6 in length, and 1½ in thickness at the base.

Part 1 of a descriptive catalogue of the Formosan Fungi prepared by Kaneyoshi Sawada and published by the Agricultural Experiment Station at Taihoku, Formosa, dated December, 1919, reached me September, 1923. It is a handsome volume of many pages, well illustrated with full-page plates. The text is, of course, in Japanese, but the scientific names and an index to them are in Latin. The parasitic species naturally receive most attention.

A most attractive illustrated paper by Charles Drechsler on some graminicolous species of *Helminthosporium,* reprinted from the *Journal of Agricultural Research* for May 26, 1923, is the first of a series on this important and difficult genus. Among the many species discussed the following are described as new: *H. catenarium, H. dictyoides, H. siccans, H. stenacrum, H. triseptatum, H. vagans, H. monoceras, H. halodes, H. leucostylum, H. micropus, H. rostratum,* and *H. cyclops.*

Brébinaud makes some interesting observations on boletes in Bull. Trimest. Soc. Myc. de Fr. for 1921. Changes in the color of the pileus, he says, are due to variations in moisture; while the reticulations present at times on the stipe are remnants of the ruptured tubes. He claims also that the mycelium of the boletes, which develops mostly in holes made in the soil by insects and rodents, is of two kinds, one for nutrition and the other for respiration.

Dr. H. H. York, Pathologist in the Office of Forest Pathology, Bureau of Plant Industry, U. S. D. A., accepted the position of Forest Pathologist, Division of Forest and Lands, Conservation Commission, Albany, N. Y., beginning July 1, 1923. For the present, Dr. York will continue to work upon the white pine blister rust, but other forest disease work will be taken up later.

Dr. James R. Weir, who for the past ten years has been in charge of the field investigations of the Office of Forest Pathology, Bureau of Plant Industry, for District 1 of the U. S. Forest Service (Montana, Idaho, western Washington, western Oregon, South Dakota, Minnesota, and Michigan), with headquarters at Missoula and Spokane, has given up this position and is now directing the work of Pathological Collections in the same Bureau. This Office deals with the classification of fungi and maintaining the extensive mycological collections of the U. S. Department of Agriculture.

The gray mold of the castor bean, caused by *Sclerotinia ricini,* was fully described and illustrated in a handsome paper by G. H. Godfrey published in the *Journal of Agricultural Research* for March 3, 1923. The disease is a typical Botrytis blight. The perfect stage of the fungus was developed artificially and also found in nature. This disease was originally introduced in seed from India; and control measures depend chiefly upon seed treatment rather than upon fungicides applied to infected plants.

The morphology, development, and economic aspects of *Schizophyllum commune* are discussed by F. M. Essig in Univ. Calif.

Pub. Bot. for 1922. The hymenium arises in an apical cavity, which is very peculiar. The so-called lamellae are, according to the author, only the edges of smooth hymenial areas and the genus therefore belongs in the Thelephoraceae. This species can grow upon living wood if the conditions are particularly favorable, but probably does little damage.

A bacterial leafspot of the cultivated geranium (*Pelargonium*) in the Eastern United States has been investigated by Nellie Brown and the results published in the *Journal of Agricultural Research* for February 3, 1923. This is mostly a greenhouse disease, which can be largely controlled by regulating the air, temperature, and moisture and giving the plant plenty of room. All spotted leaves should be destroyed and very sensitive varieties discarded. *Bacterium pelargoni* is the name assigned to this new organism.

Cultivated and wild hosts of sugar-cane, or grass, mosaic are discussed by Brandes and Klaphaak in the *Journal of Agricultural Research* for April 21, 1923. The following statements appear in the authors' summary: (1) Thirteen species of grasses have been proven by inoculation to be susceptible to this disease. (2) All species tested for seed transmission of mosaic gave negative results. (3) Field observations indicate that natural infection of sorghum, pearl millet, crab-grass, bull-grass, *Chaetochloa magna,* and *Brachiaria platyphylla* is widespread near affected cane in the sugar-cane belt.

The origin of the central and ostiolar cavities in pycnidia of certain fungous parasites of fruits—especially in *Phyllostictina carpogena, Sclerotiopsis concava,* and *Schizoparme straminea*—has been investigated by B. O. Dodge and the results published in the *Journal of Agricultural Research* for March 3, 1923. The following is quoted from the author's summary: "The intermediate stages in the development of the pycnidia of three species of fungi associated with fruit rots have been studied, and in each case it has been shown that the initial stage in cavity formation consists in the disorganization of cells in a certain region, accompanied by

a swelling of the cell remains. The pressure thus resulting tends to enlarge the cavity, maintain a symmetrical contour, and contribute further toward cell destruction or change of form. Further enlargement of the cavity may be effected by the growth of elements already present or by the addition of new tissue."

A recent important bulletin on potato wart published by the U. S. Department of Agriculture contains the following: "A number of American varieties of potatoes have been shown to be immune to wart caused by *Synchytrium endobioticum* (Schilb.) Perc. This conclusion is based upon tests extending from one to four years in which such varieties remained free from wart infection when grown in heavily infested soil in which susceptible varieties were generally and severely infected.

"Most of the varieties of tomatoes tested have proved to be susceptible to wart, but some of the tests have been inconclusive, and it is not yet certain whether different degrees of susceptibility and resistance exist in the tomato. In general, the tomato becomes infected less readily than the potato, requiring particularly favorable environmental conditions and appropriate stages of host development.

"A number of solanaceous plants, including the native solanaceous weeds of Pennsylvania, and the eggplant, tobacco, petunia, and pepper, which are in common cultivation, have been tested for susceptibility to the wart pathogen, but infection has thus far failed."

THE EUROPEAN MISTLETOE[1]

Professor K. von Tubeuf, the well-known Plant Pathologist of the University of Munich, has recently published a monumental work on the European mistletoe, *Viscum album,* under the title "Monographie der Mistel." The volume, a distinguished example of modern bookcraft, is a veritable encyclopedia on mistletoe, treating the subject exhaustively and critically from every conceivable angle. In view of the close relationship existing between

[1] Tubeuf, Karl von, "Monographie der Mistel." R. Oldenbourg, Munich and Berlin, 1923.

Viscum and our American genus *Phoradendron,* Tubeuf's monograph offers a wealth of information and suggestions of immediate value on this side of the ocean.

An interesting chapter is devoted to fungi found on European mistletoe. In particular a description of *Sphaeropsis visci* (Sollm.) Sacc. is given.

According to Tubeuf, the fungi found on *Viscum* are partly saprophytes which cause the breaking down of dead leaves and stems, partly of a hemiparasitic nature. *Sphaeropsis visci* comes closest to being truly parasitic.

E. P. MEINECKE

THE LARGER BRITISH FUNGI *

" The object of this Handbook," says Mr. Rendle in the preface, " is to supply an introduction to the study of the larger British fungi. When considering the preparation of a new edition of the ' Guide to Sowerby's Models of British Fungi,' by the late W. G. Smith, which had served also as an introduction to the systematic study of the larger fungi, it was thought that its value might be increased by including all the British genera of Basidiomycetes. This has now been done, and additional figures have been added from Smith's ' Synopsis of British Basidiomycetes.' The Introduction has been greatly extended, the descriptions generally have been revised and enlarged, and additional matter of economic and biological interest has been included. Mr. Ramsbottom has, in fact, rewritten the book, while retaining the form and arrangement of the original ' Guide.' "

The volume contains 222 pages of text and 141 figures. The introduction treats of fungi in general and their main groups; fairy rings; luminosity; mycorrhiza; changes in color when sporophores are cut or broken; poisonous and edible fungi; fungi as food; and the ecology of the fungi. Under Basidiomycetes, the author treats at some length not only their classification, but also their cytology, morphology, and development. In connection with *Amaniata phalloides,* the deadly poisonous fungi are discussed,

* Ramsbottom, J. A Handbook of the Larger British Fungi, pp. i–iv, 1–222. British Museum, London, 1923. Price, 7/6.

with symptoms and treatment; while under *Psalliota campestris* the growing of mushrooms is described. In the same way, much interesting and valuable information is distributed throughout the volume in connection with suggestive species.

No attempt has been made to alter nomenclature or to eradicate certain errors common to most texts on this subject. The book can be recommended to students as probably the best guide to the larger fungi of England to be had in compact form, and as a very convenient introduction to most of the genera of the basidiomycetes and ascomycetes occurring in temperate regions.

W. A. MURRILL

PRUDENCE MAL PLACÉE

Une de mes amies, Mme D . . ., ardente mycophage, m'a raconté l'histoire suivante:

Dans les clairières des bois de son pays, elle fit un jour une abondante récolte de Champignons qu'elle détermina *Lepiota procera.* Cette espèce, d'excellente réputation, mais inconnue encore de Mme D . . ., lui promettait une perspective de bons dîners. En rentrant chez elle, elle passe devant une voisine qui s'exclame: "Les beaux Champignons! . . . Et bons surtout! si j'en crois mon petit livre; je vais en manger ce soir. Mais au fait, prenez-en donc; j'en ai bien pour deux." Et Mme D . . ., laisse à sa voisine de quoi faire un plat de Champignons.

Mme D . . ., de retour chez elle, se dit, tout en préparant son diner: "En somme, je n'ai pas encore mangé cette espèce; elle ressemble évidemment bien à *L. procera;* mais est-on jamais sûre? Puisque Mme X . . . doit les manger ce soir, je les mangerai demain."

De son côté, Mme X . . . se dit: "Après tout, je ne connais pas ces Champignons; puisque Mme D . . . doit les manger ce soir, je vais attendre à demain, se sera plus prudent."

Le lendemain, ces deux dames s'apercoivent: "Elle n'est pas malade, se dit Mme D . . . ." "Elle n'est pas malade, se dit Mme X. . . ." Et chacune, rassurée, mange le soir même un plat de Champignons.

Quelques jours après, Mme D . . . et Mme X . . . se rencontrent: " Il faut que je vous fasse une confidence," dit-celle-ci à son amie. " J'avais quelques craintes au sujet des Champignons, et prudemment, j'ai attendu au lendemain soir pour les manger. Vous ayant aperçue le matin, j'etais bien sûre qu'ils ne vous avaient pas rendue malade."

Mme D . . . eut d'abord un petit frisson rétrospectif; puis un fou rire la secoua de la tête aux pieds. A son tour, elle raconta qu'elle avait employé le même moyen. . . .

La morale de cette histoire est qu'il ne faut pas plus compter sur les limaces pour apprendre si un Champignon est comestible ou vénéneux.

S. DECARY
in *L'Amateur de Champignons*

WOODSTOCK FUNGI

The fungi listed below were collected at Woodstock, New York, on September 3 after a light rain which did not break the unusually severe drought, but proved sufficient to develop hymenophores in low mixed woods subject to overflow or natural irrigation during spells of wet weather. Very few species were found in the fields or upon lawns.

I was the guest of Dr. John A. Kingsbury, who was not only responsible for most of the collecting, but also arranged a handsome mushroom exhibit at his home and invited a number of Woodstock people to see it. The following day we went to Yama Farms and found other interesting specimens, among them a fairy ring of the gemmed puffball fully thirty feet in diameter.

I

Boletus luteus
Ceriomyces communis
Ceriomyces ferruginatus. Common
Ceriomyces viscidus
Clavaria flava. Abundant
Clavaria pistillaris
Fistulina hepatica. Abundant
Gyroporus castaneus
Hydnum repandum

Lactiporus sulphureus. Abundant
Leotia lubrica
Phaeolus sistotremoides
Rostkovites granulatus

II

Armillaria putrida. Abundant
Chanterel aurantiacus
Chanterel floccosus. Common
Clitocybe clavipes
Cortinarius alboviolaceus. Common
Cortinellus rutilans
Drosophila appendiculata
Drosophila Storea. A rare species
Entoloma Grayanum
Gomphidius nigricans
Gymnopus dryophilus
Gymnopus radicatus
Hydrocybe conica
Hygrophorus jozzolus
Hypholoma lateritium. Common
Laccaria laccata
Laccaria ochropurpurea
Lactaria deliciosa. Common
Lactaria grisea
Lactaria indigo. Common
Lactaria ligniota
Lactaria maculata
Lactaria piperata. Common
Lactaria plinthogala
Lactaria subdulcis
Lactaria trivialis
Lepiota naucina
Lepista personata. Abundant on a pile of grass and trash in the woods
Marasmius caryophylleus
Mycena gloiocyanea. A single specimen on a dead stick in moist woods
Monadelphus illudens. Abundant, and every specimen phosphorescent
Omphalopsis campanella. Abundant
Omphalopsis fibula
Prunulus Leaianus
Russula bifida
Russula delica
Russula emetica
Russula foetens. Common
Russula Mariae
Russula obscura. Common
Russula subusta
Tapinia lamellosa
Vaginata agglutinata
Vaginata farinosa
Venenarius phalloides. Common

III

Bovista pila
Bovista plumbea
Calvatia Bovista
Lycoperdon gemmatum
Lycoperdon cruciatum
Scleroderma subpurpureum. Common

On September 17, Dr. Kingsbury wrote me that a good rain had brought out an abundant crop of mushrooms at Woodstock. Both *Clavaria flava* and *Chanterel floccosus* were found growing in large fairy rings. *Chanterel cibarius, Chanterel cinnabarinus,* and *Agaricus campester* were collected in sufficient quantity for the table; while the giant puffball that was the size of an egg on September 3 had increased to twice the size of a man's head and was being eaten day by day, a slice at a time, without disturbing its underground connections.

Back of Outlook Mountain, Dr. and Mrs. Kingsbury found quantities of fungi with many additional species, including *Pholiota adiposa* and *Piptoporus suberosus;* the latter species occurring commonly on the trunks of white birch, which it attacks parasitically and often destroys.

W. A. MURRILL

ADDITIONS TO THE RUST FLORA OF THE WEST INDIES

The rusts have been so thoroughly collected in Porto Rico by Stevens, Whetzel, Olive, and various other visiting and local mycologists that during our recent visit we had much difficulty in finding one on a host which had not been recorded by Dr. Arthur in his work on the rusts of the island. Even the rust flora of the Virgin Islands is so similar to that of Porto Rico that little new material could be found. However, a few items of information have resulted from our work, including one new species, and it seems well to publish these fragments of additional knowledge at this time. Although the bulk of the Porto Rican collections has not yet been critically worked, so far as they could be checked in the field, no other new material in this group of fungi has been taken by us.

The work of the writer was carried on in company with Dr. N. L. Britton, whose knowledge of the phanerogamic flora of the island enabled him to supply the necessary determinations of hosts in the field. This together with Dr. Arthur's check list and host index of the rusts made it possible to readily detect species on hosts not previously reported or which were likely to be new.

The rusts from the Virgin Islands and those from Porto Rico which appeared to be of interest were sent to Dr. Arthur and Prof. H. S. Jackson, and to them I am indebted for the determinations and notes on species not previously recorded or of interest otherwise.

PUCCINIA ESCLAVENSIS Deit. & Holw.; Holway, Bot. Gaz. **24**: 29. 1897

The species was originally described from material collected on *Panicum bulbosum* H.B.K. at Esclava near the city of Mexico by E. W. D. Holway. According to Dr. Arthur the species is common from southwestern United States south through Mexico and Central America, but has not previously been known from the West Indies.

Our specimens on *Valota insularis* Chase were collected on the island of St. Thomas in the hills back of the town of St. Thomas.

PUCCINIA HUBERI P. Henn. Hedwigia Beibl. **39**: 76. 1900

The species was collected at Anna's Hope in the vicinity of the Experiment Station on the island of St. Croix. The host, *Panicum adspersum* Trin., which was determined by Mrs. A. Chase, proved to be a new host for the fungus. Incidentally the host was also new to the flora of St. Croix.

Uromyces Anthacanthi H. S. Jackson, sp. nov.

O. & I. Pycnia and aecia unknown.

II. Uredinia epiphyllous, closely gregarious and arranged in a concentric manner in areas 5–8 mm. across, tardily naked, cinnamon brown, ruptured epidermis conspicuous and overarching; urediniospores obovoid, 20–26 by 26–30 μ, wall thin, 1–1.5 μ, golden yellow, finely and moderately echinulate, the pores obscure, apparently two, slightly super-equatorial.

III. Telia like the uredinia, chestnut-brown; teliospores globoid or broadly ellipsoid, 20–24 by 26–30 μ, rounded above and below, wall chestnut-brown, uniformly 1.5–2.5 μ thick, finely and rather inconspicuously verrucose; pedicel colorless, equaling the spore or shorter.

On leaves of *Anthacanthus spinosus* Nees, St. Croix, March 18–25, 1923, *F. J. Seaver 928.*

The material is somewhat old, the center of the groups consisting of empty sori, or desiccated tissues. No evidence of pycnia or aecia was found, so that it is impossible to determine the type of life history. All other species of *Uromyces* on Acanthaceae of which we have any knowledge have teliospores with smooth walls or in which the wall is decidedly thicker at the apex. (*H. S. Jackson, Sept. 25, 1923.*)

The above description and note were supplied by Prof. Jackson. The species was collected in some abundance in the vicinity of the lighthouse near the west end of the island. The sori were at first covered so that the fungus was thought to be a *Phyllachora.* Later, some of the sori were detected in which the epidermis had ruptured, exposing the rust spores. On returning to Porto Rico a careful search was made, in company with Mr. C. E. Chardon, of the above host which occurs near Arecibo, but none of the rust could be found. It is not unlikely that the rust will eventually be found to occur there where the host is abundant.

UROMYCES SALMEAE Arth. & Holw. Am. Jour. Bot. **5**: 445. 1918

This rust was collected on two occasions in Porto Rico on *Salmeae scandens* (L.) DC. According to Dr. Arthur, the species has been known previously only from the type collection in Guatemala on the same host.

FRED J. SEAVER

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MYCOLOGIA

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STUDIES IN THE MORPHOLOGY OF THE ASCOMYCETES I. THE STROMA AND THE COMPOUND FRUCTIFICATION OF THE DOTHIDEACEAE AND OTHER GROUPS

C. R. ORTON

The morphology of the ascocarp has been a subject of continued investigation since the time of deBary and his contemporaries when the discovery was made that specially differentiated hyphae, called by Fuisting (29) "Woronin's hyphae" originate the ascogonia from which the asci arise, and from the stalks of which the perithecia are built. It appears that Janczewski (41) was the first to fully establish the origin of the asci in his studies on *Ascobolus,* but it remained for Harper (34) and later workers to establish by cytological methods the morphological significance of these structures. On the other hand the morphological characteristics and homologies of the various ascocarp aggregates or compound fructifications that are so well represented in the Pyrenomycetes are in need of much further study. These clusters or compounds of ascocarps are to be distinguished sharply of course from those cases in which the ascocarp itself arises in connection with a cluster of ascogonia as in *Pyronema, Ascodesmis, Thecotheus,* etc., as shown by the Tulasnes, Harper (35), Claussen (18), and Overton (55) respectively. Here the ascocarpic unit is itself a compound as compared with those cases in which, as in the powdery mildews, it arises in connection with a single ascogonium.

The structure of these complex fruiting bodies is extremely

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variable as shown by deBary (6) and later by numerous taxonomists who have worked with these forms. Several attempts have been made to define the various structures encountered in the many subdivisions of the group and a confusing terminology has arisen. Before such confusion can be eliminated careful comparative studies must be made to establish the relationship of the various structures on the basis of their homologies. Such studies have established already the types of the perithecial wall in a number of specific cases as Boudier (12) for instance has done in the Discomycetes where he goes into great detail in describing the external structure of the apothecium which may be glabrous, furfuraceous, tomentose or pilose. The origin and characters of these various superficial outgrowths are also of diagnostic importance according to Boudier.

In such simple ascocarps as the cleistocarps of the Erysiphaceae the wall consists from the inside out of nurse cells, protective and more or less hardened, probably chitinized cells, and appendages of various sorts.

The development of fleshy or carbonized structures which are commonly known as stromata, sclerotia, etc., in which the ascocarps are embedded or from which they arise, present as noted further problems as to the nature and methods of origin of such aggregate fructifications.

The association in many cases of conidial fructifications, with or preceding the ascocarps, which present many parallel forms to the ascogenous fructifications add further complications and to make matters still more complex the physiological effect of parasitism runs through all the groups.

The presence or absence of stromata has been long regarded as a basis for the delimitation of systematic groups of major rank but it seems to me clear that with increasing knowledge this usage is quite indefensible since in many cases it separates what are obviously on phylogenetic grounds closely related species. As the subject is of prime importance for the proper morphological grouping of the subdivisions of the ascomycetes especially, I have thought it worth while to bring together and comment upon the current practice of students of the group in this particular.

For the Dothideaceae, which have been given family rank in the

Pyrenomycetes by Fuckel (28), Winter (83) and others, and ordinal rank by Lindau (49) and Theissen and Sydow (73) in their more recent revision of these forms, the chief diagnostic characters given by most systematists are (1) the presence of a stroma and (2) the development of cavities within this stroma which are pyrenocarp-like but which lack an independent perithecial wall of the usual type. On the basis of these characters the group has been set apart as distinct from the usual type of Pyrenomycete since the time of Fuckel although several investigators, notably von Hohnel (38), Winter (loc. cit.) and Theissen and Sydow (loc. cit.), have called attention to the inadequacy of these characters as a basis for classification inasmuch as all gradations occur between species which develop a stroma with pyrenocarps appearing merely as locules without well differentiated perithecial walls (*Catacauma*) and other species which on the one hand develop definite stromata enclosing pyrenocarps with well differentiated walls (*Nummularia, Hypoxylon*), and on the other develop groups of pyrenocarps with well marked walls but no truly stromatic elements or only scanty mycelial aggregations (*Phyllachora graminis*).

As indicated above the Dothideaceae have received quite different treatment at the hands of the systematic mycologists. Fuckel established the family on the grounds that the ascocarps lacked a definite perithecium and were embedded in a stroma. He made the genus *Dothidea* the type of family with *D. gibberulosa* (Ach.) as the type species.

Subsequent workers have clung to these characteristics in the main but have differed rather widely as to the limits of the family. Winter separated the Dothideaceae from the Hypocreaceae and Sphaeriaceae on the ground that the stroma in the Dothideaceae is always present, usually not fleshy, black or blackish-brown, and that perithecia are not formed or if formed are not well differentiated from the stroma. He included nine genera and thirty-eight species.

Lindau who first raised the group to ordinal rank separated it from the Hypocreales on the consistency of the stroma and from the Sphaeriales on its always possessing a dark colored stroma and lacking a definite perithecium. He included 25 genera and

over 400 species, of which 200 were included in the genus *Phyllachora*. Practically all of the species thus segregated by Lindau are parasitic.

Theissen and Sydow have increased the number of genera and species enormously, recognizing 140 genera of which *Phyllachora* with 322 species is the largest. They have established four families as follows: (1) Polystomellaceae: Stromata with radiating plate-like cover; ascus-stroma arising either superficially and then with an intramatricular hypostroma or wholly subcuticularly. Locules linear or circular, variously formed. (2) Dothideaceae: Stromata of parallel hyphae, prosenchymatous or more or less parenchymatous, warty or smooth, without a covering structurally differentiated, developing superficially with an intramatricular hypostroma. Locules circular, enclosed in the stroma. (3) Phyllachoraceae: Stromata under the cuticle or epidermis, remaining covered with a cuticular or epidermal clypeus, prosenchymatous dothideoid in structure or of more or less irregular hyphae. Locules enclosed in the stroma or leaf tissue, connected at the apex with the clypeus. (4) Montagnellaceae: Locules isolated; developing either in the mesophyll without stroma or with irregular hyphal, often entirely reduced vegetative stroma here and there forcing up the epidermis; or lying on an interwoven perithecium-like basal stroma; or enclosed in individual stroma-columns.

Their last family especially needs more careful study to determine its affiliations. The lack of stroma indicates relationships with the Sphaeriales and the lack of perithecial walls indicates relationship with the Dothideaceae according to their views.

The whole order consists almost exclusively of leaf parasitic forms which is rather remarkable and either indicates that the reduction in structure of the perithecium is associated with parasitism or that the saprophytic forms have not been studied so thoroughly.

Since we are concerned in this study with definite structures, the terminology of which has been rather loosely applied by the various students of the Ascomycetes, it is in place to briefly review the usage of these terms and to delimit them in so far as possible for the presentation to follow.

The earliest use of the term stroma appears in the work of

Persoon (57) who employed it to describe the structures on or in which are borne the pyrenocarps in the genus *Sphaeria*. He made eight divisions of this genus based on variations in the shape, etc., of the stroma.

In his later work, Persoon (58) uses the term only in connection with the "receptaculum" in his group "Sphaeriis" as follows: "In Sphaeriis carnose suberosum est et stroma audit." As examples he includes *Sphaeria militaris* (*Cordyceps*), *Xylaria* spp. and *Hypoxylon* spp. He also uses "receptaculum" for the fructification in the Pezizaceae, for the pileus of Basidiomycetes, etc. From this it is apparent that he considers stroma and receptaculum synonymous but prefers the term stroma for the matrical complex in the Sphaeriaceae.

In the glossary of technical terms S. F. Gray (33) gives the very misleading definition of stromata as "Irregular apothecia in which the sporae are immersed. *Sphaeria*."

Fries' (27) usage of the term is also essentially that of Persoon, *i.e.*, a matrix in which pyrenocarps are imbedded. "Uterus subinduratus, perithecium dicitur, plura stromate communi saepe juncta; nucleus subgelatinosus." He mentions stromata more specifically in connection with the genus *Dothidea* (p. 318).

Leveillé (45) does not use the term stroma but uses receptacle in a synonymous sense. He applies the term conceptacle to the ascocarps in the Hysteriaceae, Phacidiaceae, and Sphaeriaceae.

Berkeley (8) says of the Sphaeriaceae, "The stroma may be developed in varying degrees, being more or less intimately incorporated with the bark, or it may be quite free, assuming various degrees of consistence, and, according to its mode of expansion or elongation, affording very excellent characters. Thus we have the multitude of pustular or stromatic species, which grow on the branches of trees, or on decayed wood; while the more elongated clavate or simply globose forms yield the species of *Hypoxylon* and *Cordyceps*. Some of the most beautiful are those which grow on insects (Ex. *Cordyceps Robertsii* on *Hepialus virescens*)."

Cesati and de Notaris (16) applied the term in the sense of Persoon's later usage to the receptacle. They discuss the vari-

ations in form of the receptacle from the standpoint of its value in the taxonomy of the Sphaeriaceae.

The Tulasnes (77) employ the term stroma for the fructifications in their family Xylariei which form conidia first and after further development, the perithecia. They recognize four types of stromata: (*a*) "stromate fructiculoso" (Ex. *Xylaria polymorpha,* etc.), (*b*) "stromate repando pulvinato" (*Ustulina vulgaris* and *Poronia punctata*), (*c*) "stromate effuso" (*Eutypa* spp.), and (*d*) "stromate pulvinato vel placentiformi" (*Dothidea Ribesia* Fr., *D. melanops* Tul., *Polystigma rubrum* Pers., *Melogramma Bulliardi* Tul., *M. rubricosum* Tul., *M. gastrinum* (Fries) Tul.).

In connection with the family Valsei which includes *Diatrype disciformis, D. Quercina, Quaternaria Persoonii* Tul., *Calosphaeria, Melanconis, Cryptospora and Valsa,* the stroma is mentioned by the Tulasnes only incidentally. Neither do they describe stromata as of diagnostic importance in the species of their family Sphaeriei which include the genera *Cucurbitaria, Massaria, Sphaeria, Pleurostoma, Pleospora,* etc.

In their later volume the Tulasnes (78) treat the Nectriei, Phacidiei and Pezizei. In the Nectriei they include the genera *Torrubia* (*Cordyceps*), *Epichloe, Hydnopsis, Hypocrea, Hypomyces, Nectria* and *Sphaerostilbe.* In the genus *Torrubia* they designate the stroma as follows: "*Stroma* (*Sporidochium* Link.) carnosum nunc in brachia sparsa aut caespitosa, simplicia vel divaricato-ramosa discedit, nunc contra in columellas crassiores, saepius simplices, erectas, sursum claviformes aut capitatas informatur, semper autem e matrice, quaecunque sit, emergit. Pars summa stromatis gracilioris et ramosi in conidia minima, globosa aut breviter linearia, pallida et pulverea fatiscit; columnae validiores ascophorae evadunt." However, in *T. coccigena* Tul. they say " . . . mycelii intestini causa in stroma solidum matatur ex quo flagella et columella fertiles proderunt." *Hypocrea rufa* Tul. possesses stroma but *Hypomyces* only vegetative, more or less loose or flocculent mycelium in its fungous hosts. *Nectria* possess stromata which first give rise to conidia, and upon their surfaces the ascocarps are later produced. *Epichloe typhina* forms a more or less dense fleshy structure with its host tissues and they men-

tion its resemblance to *Claviceps* but they do not call this structure either stroma or sclerotium. *Sphaerostilbe* is like *Nectria* except the conidia are borne on the apex of a column arising from the stroma.

In the Phacidiei, according to the Tulasnes, *Rhytisma* possesses a stroma which is like a sclerotium, covered with a cortex. *Stictis ocellata* (Pers.) Fries has a well developed stroma which first produces conidia from the surface and later the discocarps arise within the stroma. *Phacidium Ilicis* forms its ascogenous stroma from the pycnidial structure.

Certain of the Pezizei as *Cenangium* and *Dermatea* form well developed stromata according to these workers. From the above examples it will be seen that the Tulasnes had very definite ideas as to what constitutes a stroma but that they made taxonomic use of this structure only in their classification of the Xylariei.

An important contribution to our knowledge of the stroma was made by Fuisting (loc. cit.) who carefully investigated the vegetative structures of several Pyrenomycetes, including *Stictosphaeria Hoffmani* Tul., *Diatrype Quercina* Pers., *D. disciformis* Hoffm., *Eutypa lata* Pers., and *Nummularia Bulliardi* Tul. In the last named species he distinguishes as *epistroma* a hyaline pseudoparenchymatous crust formed in the outer layers of the primary cortex of the host which produces conidia. Under this crust a *hypostroma* is produced later in which the perithecia develop. Ruhland as will be shown later in his use of the terms *ectostroma* and *entostroma* has followed this conception of Fuisting. In my opinion the distinction of *epistroma* and *hypostroma* as made by Fuisting is of real morphological significance and since they are earlier terms and seem from the etymological standpoint to be preferable it would seem that they should supplant Ruhland's terms.

In *Quaternaria Persoonii* Tul. the epistroma is well developed and takes part in the resorption of the periderm. The "Woronin hyphae" develop within this structure. In Fuisting's discussion of *Hypoxylon* and *Xylaria* he employs the term stroma in the sense of its present application to these forms.

In a later paper Fuisting (30) describes *Poikiloderma bufonium* Berk. & Br. which possesses a rudimentary stroma, and *Massaria*

polycarpa, *M. rhodostroma*, *Bathystomum amblyosporum*, and *B. circumcissum* which form well developed stromata. The stromata of the two later species are of the diplostromatic type of Ruhland.

Nitschke (54) like the Tulasnes differentiates four types of stromata as follows on the basis of their general form: (*a*) *Xylaria*-stroma, (*b*) *Hypoxylon*-stroma, (*c*) *Diatrype*-stroma and (*d*) *Valsa*-stroma.

Fuckel (loc. cit.) uses the term stroma in the Persoonian sense. He established the family Dothideaceae Nitsch. with the following characterization. "Die Schlauch liegen in, nicht weiter gesonderten, von keiner eigenen Haut umgebenen, Zellen, im Innern des Stromos." He names *Dothidea* Fries as the type genus of which *Sphaeria gibberulosa* Ach. is the type species. It is of interest to note that Fries (26) came to the conclusion that *S. gibberulosa* cited as the type species of *Dothidea* was synonymous with *Arthonia moriformis* Acharius and later in his Systema (27) he cited *D. moriformis* (Ach.) as the type of the genus *Dothidea*. Since it appears that this species is not dothideaceous but probably belongs to the Discomycetes we have the anomalous situation of recognizing the name Dothideaceae when the genus *Dothidea* upon which it was based should be dropped because its type does not conform to the characters established for the family.

An interesting account of the development of the fructification in the asterinoid types has been made by Ward (82) who investigated *Asterina* (*Dimerosporium*) *spissa* Syd. According to Ward the disc or radiate plate so characteristic of these forms develops as an outgrowth of one or two hyphal cells. The center of this disc becomes raised by the formation of a closely packed mesh of hyphae which evidently are produced from the under surface of the cells of the disc. Within this mass the primordia appear which in his opinion are made up of ascogenous hyphae, the origin of which is not clear. Ward considers the disc as a stroma.

De Bary's (6) use of the term stroma is again scarcely different from that of Persoon. It is for him a crust or cushion or an erect more or less branched body on which or in which the ascocarps are developed. He goes so far however as to include the disc or saucer shaped fruit bodies of the discomycetous lichens in

the same category. Stroma and receptacle are for him essentially synonymous.

Goebel (31) defines stroma in the sense of de Bary, but as noted later he is keenly aware of the morphological significance of the stroma and stroma-like structures.

Winter (loc. cit.) in his descriptions of the stroma notes that it is difficult to be sure of its character in cases in which it consists essentially of the more or less modified thickened and blackened substratum. He would regard the typical stroma as a pseudo-parenchymatous mass in which cavities are hollowed out for the production of asci, these cavities having no differentiated walls. He is explicit in holding that a stroma is present in those forms in which as in *Homostegia Piggotii* (Berk. & Br.) Karst. the pyrenocarps with their perithecial walls are well individualized and lie in a very loose mycelial network, the dense pseudo-parenchymatous material appearing merely as an upper and under crust between which the pyrenocarps lie. To be excluded from the Dothideaceae are those forms in which the stroma consists of a dense dark rind and a sclerotium-like medulla in which the pyrenocarps are imbedded, the pyrenocarp walls being also sharply differentiated and separated from the matrix in which they lie.

Brefeld (14) and von Tavel (67) hold that the Pyrenomycetes are the only forms which possess a true stroma.

Ellis and Everhart (23) follow the Persoonian usage of the term.

Jaczewski (40) makes the presence and absence of stroma the basis for dividing the Pyrenomycetes in two groups: (*a*) "Pyrenomycetes simples," without stroma, and (*b*) "Pyrenomycetes composes," with stroma. In his usage of stroma he includes forms in which the context consists merely of loose and wefted hyphae as well as those of denser consistency.

In his systematic treatment of the Ascomycetes Lindau (47) considers the fruit body of certain sub-families of the Pezizineae, viz., Cenangiaceae, Cordieritidaceae, Cyttariaceae and Phymatosphaeriaceae, to be made up, in part at least, of stroma. He considers the fruit bodies of the whole group Phacidineae as having stromatic characters as well as a part of the Hysteriineae. But he does not define the stroma as found in these groups.

In the Pyrenomycetes, Lindau (48) considers any fleshy structure appearing as a matrix for ascocarp formation as stroma. For the Dothideales he notes: "Gehause typisch von der Stromasubstanz nicht abesetzt, bei einiger nur zum Teil, bei anderen aber deutlich geschieden."

Ruhland (60) has studied quite fully the development and structure of the stromata for a number of the Sphaeriaceae. He distinguishes as *ectostroma* the earlier and more or less vertically developed structure which generally produces the conidia when they are present, and as entostroma the inner and later developed structure which produces ascogonia though he also regards the ectostroma as a direct product of the undifferentiated mycelium which is destined to become the entostroma. Those species like *Diatrype discisformis* (Hoffm.) Fries develop the early stages of the ectostroma within the periderm of the substratum. This is at first a lens-shaped structure which by continued growth at the center becomes cone shaped and ruptures the periderm, a main function of the ectostroma according to Ruhland. From the lateral surface of this cone the conidia are produced after which the outer portion of the cone including the conidial hymenium turns brown and dies. The mycelium from which the ectostroma develops remains meristematic and after conidial production has ceased, hyphae from this layer grow inward to the cortical parenchyma of the host just outside the sclerenchyma layer. These hyphae then spread out tangentially to the host and by dissolving and pushing apart the cells build up a loose cushion-shaped plectenchyma within which the primordia of the several ascocarps develop. From this same entostroma *anlage* which gave rise to the plectenchyma, a further outward and slightly downward growth now takes place. This spreads out into a porous plectenchymatous layer which eventually becomes denser and covers the structure in which the ascocarps are developing. This layer also effectually cuts off the dead outer ectostroma and the latter is sloughed off. Later another plectenchymatous layer is produced below the ascocarps and by tangential growth this may fuse at its margins with the overlying similar layer. Thus the several pyrenocarps become enclosed.

Ruhland differentiates the "primordial layer" producing the

ascocarps under the term *placodium,* and since in the case noted above it originates from the entostroma, he characterizes this type as *entoplacodial.* He traces transition stages from the entoplacodial type to his ectoplacodial type through *Diaporthe leiphaemia* (Fries) Sacc., *D. Berlesiana* Sacc. & Roum., *Endothia radicalis* (Schw.) Fries, *Fenestella* and *Cryptospora suffusa* (Fries) Tul. in which the entostroma becomes reduced and the placodium is formed in part at least from the ectostroma. In his ectoplacodial group of which *Melanconis stilbostoma* (Fries) Tul. and *Hercospora Tiliae* (Pers.) Fries are representatives, the *placodium* is formed from the ectostroma directly and the entostroma is only slightly developed.

From these latter forms it is but a step to his *haplostromatic* type in which the entostroma disappears and the perithecial initials develop within and near the base of the ectostroma. This type is represented by *Pseudovalsa lanciformis* (Fries) Ces. & de Not., *Botryosphaeria melanops* (Tul.) Wint., *Valsaria* spp., and the Xylariaceae. Both conidial and perithecial stages may be produced as in *Botryosphaeria* within the same stroma and without differentiation into special parts. He thinks these are the highest types of the Sphaeriaceae.

Traverso (75) has brought together and discussed the nomenclature of the various organs and structures found in the pyrenomycetes. He has attempted to define these terms according to their usage in taxonomic work but without consideration of their real ontogeny. He has classified stromata according to their structure and position, a method which will be helpful in systematic work provided further morphological studies warrant such applications.

Baccarini (3) has investigated a number of species which have been classed among the Dothideaceae by Saccardo and others. He concludes that there are two types of stromata: (1) spurious or *protostroma,* and (2) *sclerotiaform.* In the first he states that the perithecia have their origin either in a plectenchyma or in the case of *Phyllachora Bromi* Fuckel, *Ph. Poae* (Fuckel) Sacc. and *Dothidella fallax* Sacc., under and separately from such a stroma. In these forms developing ascogonia from a plectenchyma he also includes *Ph. graminis, Ph. punctiformis, Ph. amphidyma* and *Ph.*

melanoplaca (Desm.) Sacc. It should be noted that in these forms Baccarini considers that the dense tissue found in the epidermis and about the ostioles partakes of the character of an excipulum which is colored brown and is resistant and stratified. He thinks the stroma is digested and dissolved during the development and maturation of the perithecia.

In his second type he includes a number of species which develop a much more compact stroma such as *Scirrhia rimosa* (Alb. & Sch.) Fuckel, *Rhopographus filicinus* (Fries) Nitsch., *Euryachora Sedi* (Link.) Fuckel, *Dothidea puccinioides* (DC.) Fries, *Plowrightia Mezerei* (Fries) Sacc. and some other forms as *Mazzantia* spp. which Theissen and Sydow exclude from the Dothideales.

In *Scirrhia rimosa* the stroma forms either intracellularly in the epidermis or intercellularly between the epidermis and the sclerenchyma. In the first case the epidermal cells are broken and the lower halves of these cells remain in the interior and the upper halves form a cover for the stroma. In the second case the whole epidermis is pushed up. In both cases the outer layer becomes differentiated into a browned zone. The perithecia have their origin in the base of the stroma as clusters of delicate hyphae which by growth and dissolution form the cavity in which the asci are developed. His description of this phenomenon is not illustrated.

He concludes that in general the primordia of the ascocarps in the Dothideaceae arise independently of the reserve tissue constituting the stroma. He thinks they arise from independent filaments which twist between the cells of the stroma and remain there compressed until the moment of activity, although he cannot draw an analogy in the case of *Rhopographus filicinus* in which he says the primordia appear to arise from some of the cells of the stroma under the cortical layer. According to their method of formation, he recognizes two sorts of stromata: (*a*) those formed by aggregation of hyphae (symphogenic) and (*b*) those formed by segmentation of hyphae (meristogenic). Both types may be formed by the same fungus, as in *Dothidea Sambuci* (Pers.) Fries and *Ph. Junci* (Fries) Fuckel. He thinks the Dothideaceae correspond to Ruhland's haplostromatic types, and he believes the

group is an unnatural one which should be dropped since he is of the opinion that pyrenocarps in every case will be found to have perithecial walls.

Seaver (62) in his monograph of the Hypocreales establishes two families: (1) Nectriaceae and (2) Hypocreaceae. In the tribe Creonectrieae of the first family conidium-producing stromata are formed, the perithecia arising within them later. In the Hypocreaceae the stroma is conspicuous on a substratum or arises by a stalk-like growth as in *Claviceps* from a sclerotium, except for the genus *Hypomyces,* in which the stroma consists of a loose cottony subiculum, which is probably to be reconsidered as a loose plectenchyma homologous with stroma and has been so interpreted. Seaver's tribe Creonectrieae would be interpreted as corresponding with Ruhland's haplostromatic type.

It is a little more difficult to homologize the species in the Hypocreaceae with Ruhland's terminology. In the case of *Claviceps purpurea* the "sclerotium" is formed from the basal portion of the loose conidial structure by a hyphal growth into the ovary which becomes completely penetrated and mummified. Later this "sclerotium" gives rise to a stalk in the specialized apical portion of which the ascocarps arise. In this case the "sclerotium" is apparently homologous with Ruhland's entostroma in his diplostromatic group, though of course the conidial hymenium of *Claviceps* is much reduced and is hardly to be considered an ectostroma; or this fungus may be considered to belong to the haplostromatic group in which the ectostroma is much reduced. The stalk is to be interpreted as a structure formed from the entostroma specially adapted for spore dispersal. In the case of *Cordyceps militaris* the sclerotioid body of the insect is apparently homologous with Ruhland's haplostroma since it produces conidia and later gives rise to a specialized stalk in which the ascocarps are produced. The possible differentiation of the structures formed within the body of the larvae, into *ectostroma* and *entostroma,* should of course be considered. While it is my belief that most of those structures in the ascomycetes to which the name "sclerotium" has been applied will eventually be shown to be stromata it is manifestly impossible at present to homologize any considerable number of them with the structures described by Fuisting,

Ruhland and others since, as pointed out elsewhere, detailed morphological studies must be made upon the origin and development of may sorts of sclerotia before final judgment can be made regarding them.

Vuillemin (81) following the example of Baccarini attempts to differentiate two sorts of apparently parenchymatous fungous tissue according to their method of formation. For fungous tissues which are built up by the welding of hyphal elements he proposes the term *synenchyma,* and for similarly appearing tissues which arise by cell division in several planes the term *mérenchyma.* As examples of mérenchymatous tissue he cites the vegetative points in the rhizomorphs of *Armillaria mellea* " (Istvanffi 1891)," in the margins of the pileus of many Hymenomycetes, in the formation of the pycnidium of *Cucurbitaria Berberidis* as figured by Brefeld, in the perithecia of *Sporormia* as figured by Dangeard (1907), in the ascogones of *Penicillium vermiculatum,* and in the origin of the stroma in *Rhopographus filicinus* as described by Baccarini. The distinction breaks down he thinks in the case of *Phyllachora, Plowrightia* and *Dothidea* where he says the stromata are both synenchymatous and mérenchymatous. In my opinion the evidence presented for the existence of true parenchymatous merenchyma tissue formation in stromata is highly inadequate.

Wollenweber (84) in discussing the *Fusarium* problem defines stroma as " the bed at the base of sporiferous stages and is always present. It may be reduced to scattered hyphae, within or on the host, or it may be an aerial or immersed mycelial layer the consistency of which is either loose or plectenchymatic." He believes, however, that the stroma is of doubtful taxonomic significance.

Theissen and Sydow (73) ignore Ruhland and hold practically to the usage of Persoon. They attempt where possible to restrict the term stroma to the extramatrical as contrasted with the intramatrical portions of a fungous fruit-body, the latter being distinguished as the intramatrical stroma, often called by them the hypostroma.

For those dothidioid forms which have their stromata embedded within the host (Phyllachoraceae and Montagnellaceae in part) they differentiate " palisade-stroma " (*Catacauma biguttulatum*)

and "prosenchyma-stroma" (*Rhopographus filicinus*) though they admit that numerous intergradations are found.

Butler (loc. cit.) characterizes the fungous stromata as the mycelium condensed into pseudoparenchymatous masses irrespective of their relation to the host. He states that stromata differ from sclerotia only in their less regular shape and in having a margin less sharply delimited from the rest of the mycelium. Butler finds it difficult to restrict the term stromata, as some investigators have done, to those structures upon or within which spore-bearing organs are formed, since he wishes to regard as stromatic crusts or masses structures which are not known to produce spores, like those of *Rhizoctonia*. It seems clear however that the last had better be regarded as sclerotia although their homology with the true sclerotia of other Basidiomycetes is not apparent at the present time.

Other Stroma-like Structures

There are further a number of structures which have been given distinctive names such as *sclerotia, xyloma, asteroma, xylostroma, astoma, tylostoma, mylitta, ectostroma, sporodochium,* and *pseudosclerotium* which remain to be considered in their relation to ascomycetous stromata. Of these structures, the "sclerotia" are the most important.

Sclerotia.—This name originated with Tode (74) who erected it as a genus with the following characterization: "Fungus simplicissimus, globoso-oblongus; substantia tenacei, duriuscula, centro demum subhiante; cortice inseparabili, superne nunquam dehiscente; fructificatione interna, ignata. *Obs.* Notis hisce genus novum a Lycoperdo fatis dispesctur." He included eight species of which it is somewhat doubtful whether any are now known as sclerotial stages of Ascomycetes. One of his species, *S. mucor,* is evidently the common sclerotium of an Agaric like those studied by Brefeld (13). His other species are indeterminable.

The name *Sclerotium* was used in the generic sense by various mycologists from Tode to the time of the Tulasnes who applied it as a common term for such bodies as the resting structure of *Claviceps*. As would be expected numerous interpretations were given. A full list of the uses of this name together with litera-

ture is to be found in Pfeiffer (59). The most common usage among the early workers was its application to the resting stage of certain Basidiomycetes. This was most natural since the one clear illustration of Tode would indicate such an alignment.

Finally the name came to be regarded in the sense of a form genus, or it was applied as a common term to any hard fungous structure which was readily separable from its substratum. In general it was regarded as possessing a brown or black rind and a medulla or central portion of closely interwoven and sometimes pseudoparenchymatous hyphal cells, often colorless. It is in this sense that de Bary and later students of the fungi have used the name, applying it with equal readiness to the large resting stages of certain Polyporaceae and Agaricaceae, for which *Mylitta* has also been used; to the asexual resting structures formed by *Botrytis;* to the small resting stages of *Corticium vagum* (*Rhizoctonia Solani*), which are only known to reproduce by mycelial outgrowths, as well as to the resting stages of a relatively large number of Ascomycetes. It seems improbable that mycologists will continue indefinitely to apply the same name to these morphologically different structures. As far as the Ascomycetes are concerned if we accept the usage of Woronin (85) for these " sclerotium " forming types we find a series of transitional stages from the diplostromatic to the haplostromatic types of Ruhland. Woronin shows for *Sclerotinia Vaccinii* Wor., *S. Oxycocci* Wor., *S. baccarum* Schroet., and *S. megalospor*a Wor. a series of forms in which the conidial is well separated and differentiated from the ascogenous fructification, the former in the leaves and stems and the latter in the fruits. The conidial fructification arises from ascospore infection and the " sclerotium " from conidial infection. In these forms the conidial fructification is plectenchymatous, developing in the spring and is short lived; the ascogenous fructification develops later in the summer, is sclerotioid and passes through a long resting period until the next spring. A similar condition exists in *S. Padi* Wor. and *S. Ancupariae* Wor. according to Woronin and Nawaschin (88). *S. cinerea* (Bon.) Schroet. and *S. fructigena* Schroet. present according to Woronin (87) a well known condition in which the conidial fructification while it may occur upon the leaves and stem, is most common upon the

fruits and is developed under the epidermis as a stromatic body from which the conidia are produced by bursting the epidermal tissues. The conidial fructification here is quite compact and is more nearly like the epistroma of Fuisting. From the base of this structure the hyphae push into the interior of the flesh and build up the sclerotioid body of mixed hyphal and host tissue which later produces the apothecia as outgrowths. It seems probable as Woronin claims that the ascogone arises in a softened region of the sclerotium though more work is needed on this point. If this is the case the body though sclerotioid may perhaps be considered as homologous with the hypostroma of Fuisting which it resembles in its method of origin following the conidium-bearing epistroma. In all of these forms functional conidia of the *Monilia* type are formed.

In connection with such forms as *S. cinerea* and *S. fructigena,* it is of interest to note that Boudier (11) established *Stromatinia* as a subgenus of *Ciboria* Fuckel for those forms in which the sclerotial structure is effused and made up in part of host tissue. Later (12) he raised these forms to generic rank. Seaver and Horne (63) state that *S. Geranii* would fall under Boudier's genus *Stromatinia.* To the somewhat similar structure in the Hypocreaceae which is made up in part of host tissue as represented by *Balansia Hypoxylon* (Peck.) Atk. the name pseudosclerotium has been applied by Atkinson (2). In my opinion this is, on the basis of present knowledge, to be considered as a composite stroma comparable with Fuisting's hypostroma or Ruhland's entostroma.

In *Sclerotinia sclerotiorum* (*S. Libertiana*) as described by de Bary and in *S. minor* Godf. and *S. Libertiana* Fuckel as described by Smith (65) and Beach (7) the conidial stage is much reduced as compared with the previously discussed species. In these latter forms no functional conidia are known to be produced. Abortive (non-functional) so-called gonidia are sometimes produced from the older mycelium but the chief function of the mycelium is to build sclerotioid bodies which, after a period of rest, may produce stalked apothecia. The primordia of these apothecia have been shown in the case of *S. sclerotiorum* by de

Bary to originate within the sclerotial structure in the same fashion as Woronin figures for *S. Vaccinii.*

Closely related to *S. Libertiana* and *S. minor* is *Sclerotinia Geranii* described by Seaver and Horne (loc. cit.) parasitic on the rootstocks of *Geranium maculatum*, and *S. Ricini* Godf., parasitic on *Ricinus communis* as described by Godfrey (32). In both of these species the conidial stage is a *Botrytis* which is the active parasitic stage and is followed by the formation of effused sclerotioid structures which are erumpent or superficial upon the diseased portions of their host.

The other outstanding Ascomycetes which form sclerotioid structures are *Claviceps* and *Cordyceps* which were briefly referred to above. In *Claviceps purpurea* (Fries) Tul. which has been studied by Fisch (25), Tulasnes (76) and de Bary (loc. cit.) it has been shown that ascospore infection results in the production of a loosely wefted conidium-bearing structure (*Sphacelia*) upon the floral organs of rye and other grasses, especially the upper part of the ovary. From the basal portion of this structure the mycelium invades the ovary and forms the horny structure, made up in part of host tissue, known as ergot. After a period of rest this sclerotioid body puts out from its interior a stalked structure of closely appressed nearly parallel hyphae which spread out and intertwine at their apex to form a globoid head near the outer surface of which the several ascocarps are produced. This condition is slightly modified in the case of *C. microcephala* (Wall.) Tul. according to the investigations of Vincens (80), who studied the germination of the sclerotioid body and found that certain groups of cells within the compact medullary portion germinate like spores and send hyphae upward which burst the rind and form the stalk with its globoid cap in which the mature ascocarps are formed. He finds in this species that the ascogonial coils originating the numerous ascocarps arise among the growing hyphae even before the stalk has emerged through the rind. Their development proceeds along with the upward growth of the stalk and the expansion of the cap. If this is found to be the case it brings the conditions in *Claviceps* much closer to those in *Sclerotinia* where the ascogonia, as noted, arise just beneath the rind of the so-called sclerotium, and aligns the sclerotium in these cases with

the hypostroma of Fuisting (entostroma of Ruhland). Further study is certainly needed on this point both for *Sclerotinia* and *Claviceps.*

In the case of *Cordyceps* as investigated by de Bary (4, 5), Brefeld (14), Tulasnes (78), Massee (52), Vincens (79) et al., the course of development varies somewhat with the species. In general the infection of the larva is supposed to come from ascospores. The fungus penetrates the skin and ramifies more or less through the body of the insect (sometimes with the aid of internally produced conidia, *C. militaris*) until a sclerotioid body or mummy of the shape of the larva is formed. Asexual sporophores of *Isaria* or similar forms are produced from these bodies in the earlier stages but later the ascogenous stalks are produced. These may be solitary or numerous and in some species branched. In general the development of the ascocarps is supposed to be like that generally given for *Claviceps*. The development of the forms which are parasitic upon fungi as studied by Brefeld (loc. cit.), Massee (loc. cit.) and Lewton-Brain (46) appear to present no striking differences.

Xyloma.—Schweinitz (1832) used the name *Xyloma* for a tribe of the genus *Dothidea* to apply to such species as *Dothidea Ulmi, D. typhina, D. fructigena*, etc., which develop compact structures made up in part of host tissue within which the sporogenous receptacles develop, as opposed to those forms which send out sporophores or develop their ascocarps upon such a body. His *D. fructigena* on rotten apples is possibly the sclerotioid stage of *Sclerotinia fructigena*. He also uses *Xyloma* again for a subdivision of the genus *Phacidium* to apply to *Rhytisma*, etc. It is in this sense that de Bary (loc. cit.) used the term for the fructifications of *Rhytisma, Polystigma*, and *Phyllachora*. With fuller knowledge of the development of these forms this term may be found to mark significant morphological distinctions.

The terms *Xylostroma, Astoma, Asteroma, Tylostoma, Mylitta, Ectostroma* (Fries not Ruhland) and *Sporodochium* have been more or less clearly connected with one or another type of stroma-like structures but none of them in my opinion has achieved any fixed morphological significance. As our knowledge increases the

conceptions on which they are based may or may not be found to have morphological value. Their usages are outlined by Pfeiffer.

It is of interest to note that *Ectostroma* was first used by Fries as a genus of the Xylariaceae as he interpreted that family. Schweinitz also used it later for a division of *Dothidea*. Whether Ruhland was aware of these usages when he applied this name to the conidial-stroma in the *Sphaeriaceae* is not clear.

As to types of variation in the structure of stromata several have been described. De Bary used the term *pseudoparenchyma* for the isodiametric, roundish or polyhedral tissue which in section does not show its make-up of thread-like hyphae but resembles the ordinary parenchyma of the higher plants except that it is formed by a union of hyphal elements by elongation and septation and not by cell division in three planes.

Plectenchyma is a term introduced by Lindau for the porous thallus in the lichens. Ruhland applies it to the twisted more or less loose hyphal structures in the Sphaeriaceae which often later become firm (*pseudoplectenchymatous*) or even horny (*paraplectenchymatous*).

Theissen and Sydow introduce the term *prosenchyma* for a common type of tissue formed in the Dothideaceae. They say "Alle diese Formen stimmen darin überein, dass ihr Verlauf immer senkrecht-parallel-prosenchymatisch ist, nicht regellos polygonalezellig, während die Hypostromaplatten selbst neben dieser (allerdings bedeutend vorherrschenden) Struktur auch die parenchymatische aufweisen können." It is questionable whether this name, which has been applied so long to the elongated cell elements of the higher plants, should be used without modification for structures in the fungi which are so different in their fundamental nature. For such tissues formed of parallel hyphae the term pseudopalisade parenchyma may well be used.

Structurally, stromata are plectenchymatous when they are made up of more or less loose hyphae and pseudoparenchymatous when their structure becomes firmer by the welding together of the hyphae. They frequently possess an outer differentiated layer which has been called the rind by de Bary and in certain special cases the clypeus by Thiessen and Sydow. This is no definite

morphological structure since it is the same in most resting fungous bodies. It may be a part of the stroma or as shown later it may be a development from the perithecium. In the case of the Dothideaceae such structures are commonly developed in the epidermal cells of the host plant and lie above, below, or on both sides of a group of pyrenocarps. Lindau's term, paraplectenchymatous, appears to apply to the sometimes hard and carbonized outer layers of true plectenchymatous stromata.

It is apparent from the foregoing that stromatic tissues have not been investigated fully enough from the ontogenetical standpoint which after all, as Goebel (loc. cit.) and Fink (24) point out, is the real basis upon which morphological conclusions should be established. It is certainly clear that the term stroma should not be used for structures developed after conjugation and built around the ascogenous elements. Stromata are regularly formed from the mycelium before ascocarp formation.

Recently a most interesting contribution to our knowledge of the Ascomycetes has been made by Arnaud (1) in his study of the Asterineae. He has brought together under this group name a large number of the tropical asterinoid fungi irrespective of their disposition by earlier workers. These interesting forms have been variously treated. They have been generally included with the Perisporiales as Lindau treated them in "Die naturlichen Pflanzenfamilien" under the family name Microthyriaceae.

Höhnel (39) working with this group noted the variation in the arrangement of the asci within the fructification which he called a *thyriothecium* and limited the Microthyriaceae to include only those forms which show the so-called "inverse radial" arrangement. This excluded a considerable number of forms with hemispherical apothecium-like fruit-bodies and led Theissen (71) to erect the order Hemisphaeriales, which he divided into three families, (1) Microthyriaceae with an "inverse radial" formation; (2) Trichopeltaceae, the shield-shaped fruit body of which is formed "pyknotisch" in the vegetative thallus as he (72) has described later in more detail; and (3) Hemisphaeriaceae, the fructification of which is hemispherical, without a thallus and not "inverse radial." The last family he divides into two tribes: (*a*)

Dictyopelteae (*Dictyothyrina*) with a closely netted membrane and (*b*) Thraumatopelteae (*Clypeolum*) with a pseudoparenchymatous membrane, breaking up into plates, yellow to brownish-black.

The affiliations of these rather variable Ascomycetes, many of which are parasites developing their ascocarps upon the surface of their hosts, were thought by Lindau and the earlier workers to be allied with *Meliola* and the powdery mildews on account of their superficial habit of growth and the fact that some of them develop haustoria within the host; but Theissen and Arnaud on stromatal characters think they should be considered as being more closely related to the Dothideaceae and Theissen and Sydow have included many of them in this group.

Arnaud has given us the first really adequate description of these forms together with a large number of plates illustrating the development of the radial plate-like structure overlying the asci and the position of the asci beneath. He recognizes among the asterinoid forms several types of development based on the grouping and position of the asci.

Protothyrium Salvadorae (Cooke) Arn. represents Arnaud's primitive type in which the elongated asci arise from the base of what he calls the ascus-stroma which is formed from the brown plate-like radiating structure which covers the fructification. This ascus-stroma is of course no true stroma but we need evidence as to the possible existence of ascogonia and their distribution before we can judge of its real relationships. He considers the diffused habit of the asci as indicating a primitive character and this species would then connect the Myriangiaceae with the Microthyriaceae since its radiating surface is like that of the latter family.

A similar "ascus-stroma" is found in many other asterinoid forms. True stromata of a ribbon-shaped structure are present in *Trichothyrium fimbriatum* Speg. and probably *Hysterostomella discoidea* (Racib.) Arn. where they form dense brown basal structures under the fruit bodies. The nature of the radiating asterinoid protective plates seem rather like that of the clypeus in the Dothideaceae than a true stroma. Each radiating system converges on an ostiole and thus defines the boundaries of an ascocarp.

Here and there throughout the group conidial stages appear and in *Leprieurina Winteriana* Arn. the conidial stage of *Prillieuxiana Winteriana* (Paschke) Arn., a conspicuous example is seen of the development of the stalked conidia from the inner surface of the overarching radial plate. If there is any analogy between the structures in the pycnidium and the ascocarp as is suggested from the studies of Shear and Dodge (64) on *Patellina, Leptothyrium* and *Peziza,* one might well interpret the formation of the conidia here as being further evidence of the inverse-radial development of the thyriothecium, but curiously enough the figures of Arnaud show the ascocarp of this species with the asci arising from the base and not inverse-radially.

The interesting explanation given by Theissen (69) for the development of the thyriothecium is noteworthy. He thinks that the development of the fruit body under the aerial mycelium brings about its inversion and prevents the formation of a cleistocarp with its apex toward the leaf. The result is the formation of a radial plate-like structure which is to be interpreted as the base of a flattened out pyrenocarp, the ostiole of which is formed in the center of the inverted base. The published figures of Arnaud are not very convincing as to the inverse origin of the asci. In those cases which most closely approach an inverse arrangement they appear rather to arise from the margin of the disk, and since transition stages to the cleistocarpous types are found it is pertinent to raise the questions whether the thyriothecium may not represent a pyrenocarp whose base is so flattened and spread out that the ascogenous elements are forced to the margin, or whether the margins of the disk may not produce numerous ascogones giving rise to the elements which develop downward and inward, the asci converging and turning up at their tips in order that the spores may escape through the ostiole in the center of the disk which in such a hypothetical case might be a stroma.

Certainly the asterinoid group shows some remarkable transition stages in the development of the fruit body from the thyriothecium through the apothecium-like structures in such marked forms as *Rhipidocarpon javanicum* et al. which Theissen (70) has described and figured under the name *Parmularia javanica* (Pat.) Sacc. &

Syd. as being closely related to *Lembosia,* and from these to the cleistocarp. They develop structures which are apparently analogous with those of the Phacidiaceae, Hysteriaceae and the Erysiphaceae. It is possible that further work among these forms will indicate a polyphyletic development which may throw more light upon the origin of these other groups. Inasmuch as they are chiefly tropical parasites and largely superficial in habit, the effects of their environment may have played an important part in their development. Whether they are to be regarded as primitive types of Pyrenomycetes as Arnaud prefers to regard them, or as more highly developed and specialized types are questions which cannot be answered at present. A more careful study of their degree of parasitism would perhaps throw some light on this phase of the subject.

It seems doubtful whether we can regard a majority of these types as forming stromata in the proper sense. If the plate-like structures do represent true stromata as Ward's studies would indicate, they show all conditions of epistromata, hypostromata and haplostromata. On the other hand the disks would appear to conform to Persoon's concept of stromata if we regard only the so-called "ascus-stroma" as conforming with his interpretation of what constitutes the pyrenocarp.

In the integration of the ascocarps they present interesting analogies with the conditions found in the powdery mildews though here again a number of forms are to be noted in the Microthyriaceae in which the disks of the individual ascocarps fuse to form an aggregate fructification which closely resembles the clypeus formation in *Phyllachora graminis* though of course without much evidence of being homologous.

The Meliolaceae described by Spegazzini, Höhnel and others from the tropics would appear to be closely related forms as shown especially by their mycelial and spore characters and present further interesting possibilities as to their exact position in a phylogenetic system. Stevens (66) has recently illustrated most of the Spegazzinian types. Miss Doidge (21) has called attention to an interesting form which has the mycelial and spore characters of *Meliola* but the ascocarp structure of the Microthyriaceae.

This transition which has of course been noted by previous workers serves to call attention again to the close relationship between such forms as *Asterina* and certain of the Meliolaceae which possess a cleistothecium approaching the radial type of structure as represented by some species of *Meliola*.

The problem before the student of the Ascomycetes is to interpret the various compounds or complexes of ascocarps with their matrices on morphological and physiological grounds and point out the homologies which exist. This problem must include the conidial fructifications both simple and compound since their resemblance to spermogonia as well as to ascogenous fructifications is conspicuous and in many cases ascocarps follow asexual fructifications and are combined with them in more or less complete vegetative continuity. I have endeavored (1) to review the literature pertaining to those structures to which the name stroma has been applied as well as other structures such as "sclerotia," etc., which have been more or less confused with stromata; and (2) to present observations upon certain forms of Dothideaceae whose method of development throws light on the general problem as to the morphological nature of the stroma.

MATERIAL STUDIED

The results reported are based on studies of material collected in the field during the growing season, killed in Flemming fixative, embedded, sectioned, and stained by the triple method. Two species have been given careful study, *Phyllachora graminis* (Pers.) Fuckel upon *Agropyron repens* (L.) Beauv. and *Catacauma flabellum* (Schw.) Theiss. & Syd. (*Phyllachora flabella* (Schw.) Thüm.) on *Pteris aquilina* L. Both of these are common throughout the eastern states and their relation to the Dothideaceae has never been questioned to my knowledge. They represent two distinct types in so far as stromatic characters are concerned.

PHYLLACHORA GRAMINIS ON AGROPYRON REPENS

This fungus was first described and illustrated by Persoon (56) as *Sphaeria graminis* on *Elymus europeus*. It was later transferred by Fuckel (28) to the genus *Phyllachora* of which it is the

type species. This name has been used by many mycologists to designate almost any *Phyllachora* occurring on grasses but a close study of the group has led me to restrict the species name *Ph. graminis* chiefly to forms inhabiting members of the Tribe Hordeae of the Poaceae. I cannot distinguish American collections of *Phyllachora* on *Elymus* spp. from European collections on this genus of grasses by a comparison of herbarium material, and the form on *Agropyron repens* is so closely identical that I see no reason for separating it taxonomically from the form on *Elymus*. The biological relations of these forms have not been investigated.

This fungus matures its ascospores in the spring within the dead leaves of its host. The first good germination of the ascospores was obtained in May from freshly collected material. At this time the ascospores germinate readily in a film of water upon a glass slide. It appears to make no difference whether the spores have escaped from the ascus or not. They appear to germinate equally well within the ascus (Plate 8, Fig. 1*a*). In this case the germ tubes grow directly through the walls of the ascus at any point. The cytoplasm of the spore passes into the tube which grows to a length of from three to five times that of the spores. The cytoplasm becomes vacuolate in the older portions of the tube and densely granular at the tip which swells noticeably and ultimately contains the nucleus (Plate 8, Fig. 1*c*). No division of the nucleus has been observed during germination. In my cultures the fungus develops no further in water or upon nutrient agars. Apparently such development is dependent upon host infection. Though more work should be done on this point it seems probable that this fungus is a very highly specialized parasite requiring a healthy host for its development after the habit of the powdery mildews, rusts, etc. The few attempts to cultivate the fungus artificially have failed, including those of Brefeld (14), and of Miss Dalbey (19) with the *Phyllachora* on corn.

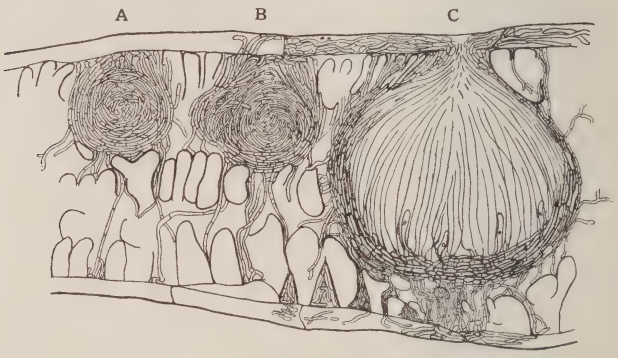
A number of attempts were made to infect potted plants in the greenhouse but without certain results. In no case was there any appearance of the black carbonaceous spots resulting from these attempts, but I have made no intensive study of infection and the conditions favoring it.

In the earliest stages of infection which I have been able to observe the mycelium of the fungus which is from 1–1.5 μ in diameter is present more or less throughout the invaded tissues including the epidermal cells of both leaf surfaces, the palisade, spongy parenchyma and even in the vascular elements. There is a distinct tendency for the mycelium to spread most rapidly in the direction paralleling the vascular elements. This is perhaps most pronounced in the epidermal cells which are much greater in length than in width or thickness. The hyphae bore their way through the cell walls of any of these tissues. This is most readily observed in the epidermis where the walls are somewhat thicker. Here the fungus apparently absorbs a portion of the wall and passes through without any noticeable constriction. The region of the wall which is perforated does not take the safranin or orange stain, remaining colorless (Plate 8, Fig. 2). Later the parenchyma tissues of the leaf are considerably disorganized. The cells become isolated and surrounded as well as penetrated by the parasitic hyphae. Their contents slowly degenerate, the cytoplasm being replaced by globular bodies taking the safranin stain. The fixed and stained host nuclei appear as a red smear and they eventually collapse. During this process a slight swelling of the leaf tissue takes place. The hyphae tend to mass just beneath either or both of the epidermal layers. At this stage certain hyphae become slightly enlarged and rather closely septate. Coils appear which resemble in their general appearance the ascogonial coils as described for the Ascomycetes in general (Plate 8, Fig. 3). I have not been able to follow the course of development of these coils nor the passage of nuclei between the cells of the ascogonium or from an antheridium if such takes place, but it seems certain that the perithecia take their origin from these coils of hyphae.

The forming ascocarp is next observed as a ball of hyphae usually developing near the epidermis (Text fig. 1*a*). The mass is made up of tangled hyphae nearly uniform in diameter and so far I have not been able to differentiate the ascogenous elements at this stage.

After the ascocarp has reached a stage where it occupies about

one-third of the distance between the epidermal layers the first evidence of color in the hyphal walls is seen. This appears in the outer layers before the internal differentiation of paraphyses or asci is noticeable (Text fig. 1*b*). The hyphae which are thus



TEXT FIG. 1.—Semi-diagrammatic drawing of progressive stages in the development of the ascocarp in *Phyllachora graminis*.

A. Early stage showing penicillate structures pushing against epidermal cell wall. Perithecium not differentiated.

B. A more advanced stage showing early perithecium differentiation and penetration of epidermis by penicillate structures.

C. Later stage showing parophyses; the early appearance of the asci; and the development of the clypei in upper and lower epidermal cells.

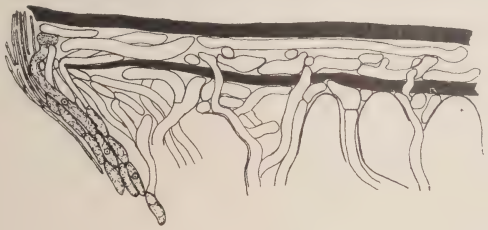
changed take on a more pseudoparenchymatous appearance, the walls become closely cemented together and thicken slightly. This is followed closely by the appearance of the paraphyses which apparently resorb the inner hyphal mass. They develop abundantly and come to fill the entire central region of the pyrenocarp which has become more symmetrical and by this time fills half or two-thirds of the distance between the epidermal layers. The young asci are now observed pushing up among the paraphyses from the base of the perithecium (Text fig. 1*c*).

The ascocarp continues to enlarge until it usually occupies the entire space of the leaf parenchyma and further growth results in a noticeable swelling or bulging of the leaf at this point and a further disorganization of the mesophyll tissue. The maturation of the asci and ascospores then ensures.

That a progressive formation of ascocarps takes place beginning

in the earlier region of infection and extending laterally is clear from the fact that in any median section of the functioning area the most mature ascocarps are seen near the center and the least mature at the margin of the infected area (Text fig. 1). The very early stages of ascocarp formation are to be found at the margins of the developing spot, as is generally the case in the Pyrenomycetes as well as in the Perisporiaceae.

The first evidence of the formation of the so-called clypeus is noted during the later stages in the growth of the ascocarp. At the time when the first evidence of color appears in the outer cells of the young perithecium, outgrowths of the upper layers of the pyrenocarp wall appear. These outgrowths suggest at once the well known penicillate structures whose cytological details are described by Harper (35*a*) in *Phyllactinia*. They form a short branched pillar-like structure over the ascocarp pushing against the lower wall of the epidermis (Text fig. 1*a*, *b*) which is then penetrated, apparently by enzymatic action (Text fig. 2). The



TEXT FIG. 2.—Showing a portion of an epidermal cell containing hyphae which form the clypeus; the penetration of lower wall of the epidermal cell by the outer hyphal elements of the ascocarp; the periphyses which take part in the resorption of the perithecium and the absorption of the outer epidermal wall to form the ostiole.

further lateral growth of these enlarged hyphae in the epidermal cells results in the formation of the clypeus (Text figs. 1 and 2). It usually extends well beyond the lateral boundaries of the ascocarp thus forming a roof-like structure within the epidermal cells.

The clypei of the separate ascocarps are formed progressively in any group complex. The fusion or intermingling of these lateral growths at their margins results in the formation of a continuous clypeus over the whole fruiting complex. In the same way a

continuous clypeus is formed in the lower epidermis which results from similar downwardly directed hyphal growths originating from the outer basal cells of the perithecium (Text fig. 1*c*). Thus a group of ascocarps is protected both above and below by a carbonized network of stout hyphal threads often embedded in infiltration products. It is this structure together with the apical and basal outgrowths from the perithecia and the fact that the pyrenocarps are closely pressed and even fused together which suggest the presence of a stroma in *Phyllachora graminis*. In fact, no typical stroma is formed by this fungus so far as I have studied it in *Agropyron repens* and *Elymus canadensis*. Further evidence of the lack of stroma is furnished by photographs of the interperithecial spaces when the perithecia are slightly separated (Plate 7, fig. 1). It appears that the outgrowths of hyphae from the upper surface of the perithecium are more nearly related to the "neck" of the pyrenocarp as first described by Fuisting (29), and as a matter of fact the clypeus of each individual ascocarp is a lateral intraepidermal prolongation of these hyphal processes.

The invasion of the vascular elements is most readily observed in longitudinal section. The hyphae pass into the large parenchyma cells surrounding the bundles and these cells are quite generally destroyed as is evidenced by the appearance of the bundles in cross section (Plate 7, fig. 2). The similar sclerenchyma cells and the partial starch sheath surrounding the prosenchyma are often partially destroyed. While the phloem and xylem are not generally directly invaded by the parasite, cases have been observed where the development of the ascocarps has resulted in the complete destruction of portions of these tissues. Such cases appear where an ascocarp is initiated in rather close proximity to the bundles. The active elements in such cases of absorption appear to be the hyphae which develop from the external layer of the perithecium. These hyphae, like those which absorb the inner wall of the epidermal cells in forming the clypeus as noted previously, penetrate readily into the xylem and phloem absorbing the walls in part and in part growing into and filling the cells for some distance. These phenomena of absorption, replacement and engulfment are perhaps the most striking physiological character-

istics of this parasite. It is remarkable that these changes may take place without any external evidence of necrosis of the host, a feature which is quite characteristic of the group.

DEVELOPMENT OF PARAPHYSES AND ASCI

The first appearance of the filiform paraphyses in the young ascocarp has already been mentioned. They appear at an early stage and fill the perithecium quite completely. It is apparent that they originate from the inner basal layers of the young perithecium and grow upward and at the same time converge until their tips approach each other near the apex. Similar elements, the periphyses, project into the cavity from the apical portion of the perithecium. It is these structures which appear to be concerned chiefly with the resorption of the overarching membranes of the perithecium and clypeus to form the ostiole. This resorption is progressive with the growth and convergence of the periphyses but the completion of the ostiole does not take place until after the asci have begun to appear. The resorption of these outer tissues to form the ostiole is quite analogous to the ostiolar development in *Massaria* as described by Fuisting (30).

The visible development of the asci starts about the time the paraphyses are mature and the ostiole nearly or quite formed. They first appear pushing up between the bases of the paraphyses. They are binucleated at first and their development and that of the ascospores is typical of what is found in the Ascomycetes generally. Fusion followed by three divisions takes place and the spores are cut out as described by Harper and later workers. All of this development takes place in the fall although apparently the ascospores are not discharged until spring. *Phyllachora graminis* in this respect again differs from those stromatic forms in which the ascigerous development does not take place until spring.

The orientation of the pyrenocarp with reference to the epidermal surface of the host leaf is variable. Within a single group of several perithecia all kinds of orientation may be found. It seems most common to find the ostioles opening through the upper epidermis but frequently they open through the lower and in some cases through the side of the perithecial wall into the interperithe-

cial cavities when such are present. In such cases the fungus takes on the form described by Müller (53) as *Diachora* except that the asci arise from one side only of the perithecium. The explanation of these differences in orientation appears to be the position of the coiled knots which initiate them. If these arise adjacent to the upper epidermis the base of the perithecium will be near the lower and the ostiole develop in the upper surface of the leaf. The converse may take place or in rarer cases the perithecium may be placed at right angles to the usual mode of orientation and in this case it seems probable that the ascogonia arise in the mesophyll midway between the two leaf surfaces.

CATACAUMA FLABELLUM ON PTERIS AQUILINA

Schweinitz described this fungus as *Sphaeria flabella* on *Pteris aquilina* from Bethlehem, Pennsylvania. It was transferred to *Phyllachora* by Thümen and later to *Catacauma* by Theissen & Sydow (73) on the basis of the applanate stroma, formed between the epidermis and palisade layers, which is composed of densely packed pseudo-palisade parenchyma within which the ascocarps are immersed bearing paraphyses and asci said to contain simple, colorless ascospores though I have never observed them in maturity. It is found to be rather common in Pennsylvania and New Jersey and no doubt exists rather widely at least in the eastern states.

The black stromatic structure is always confined to the upper surface of the fronds and always follows the venation. Necrosis of the tissue does not result until late in the season when the fronds begin to die naturally. At this time it is noticeable that the epidermal tissues surrounding the spots turn yellow and later brown to be followed by the normal dying of the fronds.

Development of the stroma.—I have been unable to find mature ascospores of this species and have had to depend for material to show the early development of the stroma, upon sections prepared from pinnae showing the first blackening of the epidermis. In the earliest stages observed the epidermal cells and some few of the hypodermal sclerenchyma cells contain scattering hyphae (Plate 9, Fig. 1). These hyphae branch and eventually come to fill

practically all of the sclerenchyma and adjacent epidermal cells lying outside and superior to the endodermis. These hyphae are not uniform in diameter but are conspicuously vesicular and they eventually fill these cells to the point of actual distension which is most marked in the hypodermal layer of the sclerenchyma. A longitudinal section shows the sclerenchyma cells to be greatly elongated and the hyphae traversing them in a twisted irregular fashion. Interspersed among these hyphae are the degenerated remains of the host protoplast probably mixed with infiltration products of the host which in stained preparations appear as dense black or brown irregularly shaped masses.

The first rupture takes place in the hypodermal layer by absorption of the walls and probably to some extent by the physical pressure which must be considerable in this case. The hyphae within these broken cells now turn at right angles toward the epidermis pushing it upward to form the stroma and thus causing further lateral rupture. The stroma fills the cavity completely at all times by spreading laterally in a fan-shaped manner and gradually replacing the sclerenchyma and adjacent parenchyma cells of the host by absorbing them (Plate II, Fig. 2). The vascular bundles themselves are not generally invaded by the fungus. The endodermis appears to form an efficient protection through which the hyphae do not readily pass. This fungus must hence be assumed to be characteristically a cellulose or at least a cell-wall consuming organism since the sclerenchymatous cells of the host in which it lives are poorly supplied with protoplasm or included food materials.

The vertical section of the stroma is palisade-like in appearance, the cells being enlongated and nearly vertically parallel. They are well filled with cytoplasm of alveolar appearance and are typically uninucleated. The walls are tinted a faint brown but are not appreciably thickened as in the case of the fungus hyphae taking part in the formation of rind. The whole appearance is that of active meristematic tissue.

The Rind.—Judging from the fact that some of the epidermal cells are well filled with the vesicular hyphae of the fungus before the stroma is formed I must conclude that the so-called clypeus

in *Catacauma flabellum* is formed in part from these early ramifying vegetative hyphae but it is also apparent that the stromatic elements take some part in its formation. It is thus obvious that the so-called clypeus in this species presents only an anatomical resemblance to that of *Phyllachora graminis* since its origin is entirely different. This is not strange because the external layers of most carbonized fructifications among the fungi present a similar anatomical appearance. In *Catacauma* we have thus a quite different fruiting structure than in *Ph. graminis.*

The Ascocarps.—When the stroma is well formed, there appear within it at irregular intervals the ascocarps or so-called locules in which the asci and paraphyses develop. I have been unable to trace completely the development of these ascocarps. The cells of the stroma are usually uninucleated as noted. At irregular intervals I have observed giant cells which are located near the base of the stroma. These cells are at first binucleated and easily visible under the low powers of the microscope (Plate 9, Fig. 3). They appear to have arisen by the fusion of two or more cells whose contiguous walls become resorbed so that their cytoplasmic contents intermingle. Four nuclei have been observed in some of these cells and it is possible that several cells may fuse to form them. I have observed some nuclear division figures with apparently eight chromosomes present (Plate 9, Fig. 3).

In the next stage which I have observed the ascocarp is composed of a large number of small cells polygonal in shape surrounding an area in which are developing the paraphyses and the very young asci. Only by their shape and size can the outer cells of the structure at this stage be differentiated from the stroma. These cells must later be resorbed since in the more mature stages the paraphyses and asci are surrounded by a thin layer of colorless hyphae, two or three cells thick, which resemble closely the nurse tissue of the perithecium in *Ph. graminis.* These hyphae are adjacent to the cells of the stroma (Plate 9, Fig. 4). There is no definite chitinized perithecial wall such as is formed in *Ph. graminis,* but it is clear that the mature fructification is an ascocarp with a very rudimentary perithecium.

Development of the Ascus. At the base of the developing asco-

carp binucleated cells are visible and from these the asci arise in the usual manner. Fusion takes place followed by rapid elongation of the asci which grow upward and curve inward toward the point where the ostiole is appearing. The first division occurs after the ascus has attained approximately its full length. This is soon followed by the second and third division to form the eight nuclei of the ascospores. These are usually grouped in the upper third of the ascus rather than being scattered throughout the ascus as in the case of *Ph. graminis*. The whole process is otherwise like that already described for *Ph. graminis* though spore formation does not proceed simultaneously as has been observed in *Ph. graminis*. Whether there is a degeneration of some of the nuclei in the ascus has not been determined since mature stages have not been seen.

Ostiole.—The development of the ostiole progresses as for *Ph. graminis*. The tips of the periphyses appear to be active in resorbing the stroma above and this resorption continues through the inner wall of the epidermal cell, on through the rind and finally through the outer wall of the epidermis.

DISCUSSION

Notwithstanding the loose usage of the term which is common in the literature, in my opinion the stroma is to be considered a structure of definite morphological character which, so far as the evidence has been presented by Fuisting, Ruhland, Baccarini and my own studies, is vegetative in character but it may be quite variable in structure, form and color as has been noted. It is primarily the matrix on which or in which fructifications whether sexual or asexual are formed. It appears also that it has other functions as well as those of originating the conidia and ascocarps or both. Ruhland calls particular attention to the mass action of his "ectostroma" in rupturing the periderm of the host. He thinks the entostroma possesses in a marked degree the property of absorption of the host tissues which he attributes to its nutritive activity. It may also form a firm protective covering for the ascocarps. In addition to these functions it is apparent in *Catacauma flabellum* that the stroma serves as a storehouse of reserve food

from which the ascocarps are to be developed after a period of rest. In this respect it takes on a function closely analogous with that of those compact forms which have been called sclerotia, but which so far as the Ascomycetes are concerned in my opinion are to be regarded as specialized types of stromata. It may be well to reserve the term sclerotium for the resting bodies formed by Basidiomycetes since it is apparent that this conforms with its earliest usage and sets them off with a distinctive name from those similarly appearing structures in the Ascomycetes. So far as the resorptive function is concerned I can see no reason for regarding it as a peculiar property of the hypostroma (entostroma). It is apparent in comparing the two widely different forms I have studied that this ability of the fungus to absorb or dissolve the host tissues is no more strongly marked in one than the other. Both are conspicuous for their ability to penetrate the cell walls of their hosts by dissolution but *Catacauma flabellum* is unique in confining itself so closely to the sclerenchyma and we must consider it to a marked degree a cellulose-consuming organism.

It appears impossible to bring all types of true stromata within Fuisting's interpretation of epistroma and hypostroma or Ruhland's ectostroma, entostroma and haplostroma for the reason that all of these terms have been applied to forms which develop first conidium-bearing stromata and later ascogenous stromata (in the haplostromatic forms the ascocarps are developed within or upon the conidia-producing stromata). Unfortunately also the derivation of these terms, with the exception of haplostroma, indicates position rather than function. In the Dothideaceae there are numerous forms which are not known to develop asexual fructifications and for these we have no means of determining whether the stromata are to be regarded as of the nature of epistroma (ectostroma) or hypostroma (entostroma). While it is apparent that many of these forms are haplostromatic in the sense of the derivation of this term, Ruhland's usage of the term implies a reduction of the entostroma as well as the assumption of the dual function of producing both conidia and ascocarps by this ectostroma. For this reason the stromata of *Catacauma* and other similar forms cannot be said at present to be definitely haplostromatic in the sense of Ruhland.

As to form and structure stromata are extremely varied. A descriptive terminology might be proposed following out some of the terms used by Theissen and Sydow but it is doubtful whether such terms would ever attain common usage. Since function rather than position seems of prime importance in designating stromata, for the present we may find such terms as *conidiostroma* and *ascostroma* useful to apply to stromata-producing conidia and ascocarps respectively, although attention should be called to two recent papers by Miss Doidge (22) in which she has used the term "ascostroma" in the same sense as Theissen and Sydow have used ascus-stroma for the bed upon which certain ascocarps rest. Without further morphological studies on the development of the forms described by Miss Doidge and others it would appear questionable whether either of such structures as the "ascostroma" and "hypostroma" which she has figured and described for *Mac-Owaniella congesta* (Wint.) Doidge and *Palawaniella Eucleae* Doidge are to be interpreted as types of true stromata. For forms which possess both sorts of stromata Ruhland's term diplostromatic is clearly applicable. Haplostroma is a useful term if we do not assume its origin from conidiostroma.

Stromata are widely present among the orders of the Ascomycetes but are apparently most generally present among the Pyrenomycetes. According to Ward's account of the development in *Dimerosporium spissum* the radiating crust formed in that and in apparently closely related forms of the Microthyriaceae is to be regarded as stromatic but Arnaud and Theissen and Sydow consider the outer crust as a cover to the "ascus-stroma" which arises variously beneath it. Certainly there can be no doubt regarding the ribbon-like stroma of *Trichothyrium fimbriatum* since this produces the disk-shaped thyriothecia. As for the thyriothecium itself we must await further studies as to the details of its origin and development before we can place a morphological interpretation upon these interesting forms.

Among the Discomycetes true stromata are present in a few cases which have been investigated and undoubtedly will be shown to be more prevalent than is known at present. Biffen (9) investigated *Bulgaria polymorpha* Wetts., already rather fully de-

scribed by the Tulasnes, and found that the mycelium formed a plectenchymatous conidiostroma in which pycnidia were first produced. These conceptacles later become filled with hyphae and a considerable further basal growth takes place. The ascogonia are developed within this structure. In *Sclerotinia* as noted two types of stromata according to their composition are formed. In *S. sclerotiorum* (*S. Libertiana*) the ascostroma is oval to kidney shaped or nearly spherical and is composed entirely of fungous hyphae. It undergoes a rest period of varying length but ultimately one or more ascogonia develop within it which give rise to the stalked ascocarps. This type is clearly analogous with that of *Catacauma flabellum*. In *S. cinerea* and *S. fructigena* the production of conidiostromata and ascostromata in close juxtaposition with the host is apparently analogous with the behavior of the diplostromatic forms of Ruhland. In *S. Vaccinii* and related forms the ascostromata when mature include a considerable portion of host tissues which have become invested, and therefore these are to be considered as composite stromata. The forms which Boudier has named *Stromatinia* may be considered as modified forms of the composite type in which the stromata are more diffused.

In the Stictidaceae the Tulasnes describe the development in *Stictis ocellata* (Pers.) Fries of a stroma which is formed in the primary cortex of its host. Further studies should be made especially in this family and that of the Phacidiaceae where in *Rhytisma* according to the Tulasnes and de Bary a well developed conidiostroma is formed and as a later development an ascostroma. Apparently these stromata correspond with Ruhland's diplostromatic forms which closely approach a haplostromatic condition. The development of plectenchymatous fructifications in *Cryptomyces Pteridis* (Reb.) Rehm which appear to be true conidiostromata and ascostromata respectively have been described by Killian (43) as forming in the substomatal and intercellular spaces of *Pteris aquilina*. Killian has been able to trace the development of the ascogonium within the already formed ascostroma and finds here a type which is perhaps similar to that described by Baccarini for *Scirrhia rimosa*.

In the Pyrenomycetes the development of stromata appears to be characteristic for the Hypocreaceae and the Dothideaceae with the probability of a few exceptions. In the Hypocreaceae the stromata in *Nectria, Polystigma, Epichloe* and *Hypocrea,* the ascosporic stage of *Aschersonia,* and close relatives are apparently analogous to Ruhland's haplostromatic types according to the investigations of Janowitsch (42), Hartig (36, 37), de Bary, Blackman and Welsford (10), Ruhland (61), Vincens (80) and Thaxter (68). In all of these forms conidiostromata are first produced and the ascocarps develop later within or upon them, most frequently near their outer surface. The development in *Claviceps* and *Cordyceps* as previously noted falls in line with the other forms except that the modification of the ascostromata, to form resting structures from which later develop the ascocarps on a stalk, is in case the ascogonia are similarly placed at once suggestive of the modifications found in *Sclerotinia.* In *Hypomyces* the loose plectenchyma in which the ascocarps originate appears to be a rudimentary conidiostroma according to the accounts of Maire (51) and Vincens. Apparently what is to be interpreted as a true stroma occurs in *Dothichloe subnodosa* as recently described by Chardon (17) although morphological studies have not been made upon this interesting form whose group relationships are not very clear.

Killian (44) has added to our knowledge of the Dothideaceae by his work on *Dothidella Ulmi* (Duv.) Winter in which he has traced the development of a conidial stroma formed of plectenchymmatous cells above the epidermis on the upper surface of elm leaves. This stroma forming a brown crust soon disappears but not before hyphae grow inward from its base to the intercellular spaces between the epidermis and the palisade cells. At this point a thick plectenchyma is formed which is divided into two types of tissue. On its periphery it is formed of irregular interlaced filaments and in the interior of isodiametrical cells. Centers of growth and consequent thickening take place within which the ascocarp initials develop by the formation of ascogonium and trichogyne. Cell fusion follows and a pairing of nuclei takes place in the ascogonium. The paired nuclei pass into the ascoge-

nous hyphae which appear soon to lose all contact with the ascogone. Killian considers the conidial plectenchyma as corresponding with Ruhland's ectostroma and the developing plectenchyma under the epidermis as analogous with the entostroma although he thinks *Dothidella Ulmi* differs from the forms studied by Ruhland in its more complete separation of the ectostroma from the developing plectenchyma beneath.

Stromata have been demonstrated in a considerable number of the Sphaeriaceae especially the Valseae, Diatrypeae and Xylariae. Among these groups the stromata are extremely variable in form as shown by Fuisting, the Tulasnes, Ruhland, Miss Dawson (20) and others. According to Ruhland there is a gradual transition from the diplostromatic entoplacodial through the diplostromatic ectoplacodial to the haplostromatic ectoplacodial type which he thinks presents the highest type of development. He infers a transition from the haplostromatic type to the Dothideaceae but such an inference is hardly justified since it is not clear that the ascocarps in this group develop within the conidiostroma as is the case in the haplostromatic forms with which Ruhland worked.

Lupo (50) has recently investigated the stromatic and perithecial development in *Hypoxylon coccineum*. He finds in the young, soft fruiting bodies four zones of differentiation: (1) an innermost central region composed of loose hyphae connected with the substratum; (2) a broad semi-circular zone above this which is composed of large, parallel, compacted hyphae; (3) a perithecial layer of loosely woven hyphae; (4) a narrow superficial layer composed of hyphae running parallel to the surface surrounded by loose hyphae which in turn is bounded by a cortical layer which he thinks was the conidium-bearing surface. While Lupo did not apparently observe the conidial stage it is inferred that it occurs over the exposed surface of the young stroma and precedes the development of ascogonia. He describes and figures the coiling of hyphae in the perithecial zone and believes these coils initiate the ascocarps. Of the large number of ascocarp initials but relatively few mature and of these a majority lie along the inner line of this zone. If Lupo's inference is correct,

Hypoxylon coccineum would belong in the haplostromatic ectoplacodial type as defined by Ruhland.

The morphological development of the pyrenocarp in *Phyllachora graminis* on *Agropyron repens* and *Elymus canadensis* is clearly homologous with that of the typical pyrenocarp with certain modifications. There is a progressive development of individual ascocarps within any infected host area beginning at the center of infection and extending outward, the successive development being more prolonged in one direction giving the mature spots an elongated shape. Each ascocarp appears to arise from a single ascogonium and develops asci, paraphyses and a perithecium. From the upper and often the lower surface of the perithecium hyphae grow which enter the epidermal cells to form the so-called clypeus. These hyphae developing from the upper surface of the perithecium appear to be homologous with the penicillate cells in the cleistocarp as well as with those forming the neck in the more typical pyrenocarp. In the case of *Ph. graminis* the neck is much reduced so that the mature fructification opens directly to the surface by an ostiole. In the progressive development of this ostiole the periphyses appear to be active in bringing about the resorption of the perithecium at this point.

The clypeus surrounding the ostiole is clearly a special structure. It is developed in a fashion more like that of the neck of the pyrenocarp, and its function is apparently that of a protective membrane.

There is no morphological ground for considering *Ph. graminis* as dothideaceous in the sense of its possessing stromata. It must be considered in my opinion as a much reduced type of the Sphaeriaceae in which all vestiges of a conidial stage have disappeared.

The perithecia develop a compact pseudoparenchymatous wall the outer cells of which are distinctly browned. By reason of the typically close proximity of the mature perithecia, their adjacent walls form within the host tissue a structure somewhat resembling a stroma, but when, as frequently occurs, the perithecia are not touching each other the lack of any dense fungous tissue be-

tween is further proof of the absence of a stroma. It is this feature which is the most reliable guide in the systematic study of dothideaceous fungi by means of hand sections, though of course one must realize that the presence of fungous tissues of various sorts in which the perithecia are embedded does not constitute morphological proof of the existence of stromata.

I find no evidence of the presence of any plectenchymatous stroma. There is in fact nothing more than the normal vegetative mycelium which falls far short of forming a plectenchyma such as Baccarini mentions for *Ph. graminis,* before the ascogonial coils are formed. Only by a comparative study of similar species can one be able to state how extensive this sphaeriaceous condition may be among the forms which have been classed as dothideaceous.

In *Catacauma flabellum* the morphological development is quite different from that of *Ph. graminis.* The enlarged irregular hyphae which extensively invade the sclerenchyma cells in the fronds of *Pteris aquilina* break out of the hypodermal cells to form a compact palisade-like pseudoparenchyma under the epidermis. I find no evidence of its origin from intercellular mycelium as described by Baccarini for *Scirrhia rimosa.* It forms an extensive, in section fan-shaped layer under the epidermis and the ascocarps arise within this ascostroma near its base apparently from the multinucleated giant cells, I have figured. Apparently, the origin of the ascocarps in *Rhopographus filicinus* may be similar according to Baccarini's rather brief account. The ascocarps in *Catacauma flabellum* are modified considerably by the reduction of the perithecium to a mere fringe of hyphal nurse cells which line the cavity in the stroma. Their delicate structure is such that it is not observed by taxonomists working with hand sections. In such preparations the ascogenous elements appear naked in the stromatal cavities.

Catacauma flabellum appears to be a highly specialized but much reduced type of parasitic Pyrenomycete in which not only has a reduction in the perithecium taken place but the conidial stage has entirely disappeared.

It is probable that *C. flabellum* represents the most general

FIG. 1 FIG. 2

condition existing among the stromatic Pyrenomycetes which have been termed dothideaceous, but judging from the morphology of *Phyllachora graminis,* and similar forms on grasses at least, it is evident that a considerable number of species lacking stromata have been included in this group. If we are to continue recognizing such a group it is evident that further revision is needed. Such a revision should be based on morphological grounds since it is apparent that the phylogeny of these various forms and groups can be worked out only on such a basis.

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EXPLANATION OF PLATES

PLATE 7. CATACAUMA FLABELLUM FROM PTERIS AQUILINA

Fig. 1. The same. Two ascocarps which are slightly separated showing the very definite perithecial walls and lack of stroma between.

Fig. 2. The same. Longitudinal section of leaf showing a perithecium absorbing a vascular bundle.

PLATE 8. PHYLLACHORA GRAMINIS FROM AGROPYRON REPENS

Fig. 1. *a,* Ascospores germinating in ascus. *b,* Germinating ascospore with nucleus midway in germ tube. *c,* Same, with nucleus in appresorium-like apical swelling.

Fig. 2. Cross section of epidermal cell showing penetration of hyphae through lateral walls.

Fig. 3. Ascogonial coil with two adjacent cells which are larger, more densely filled with cytoplasm and with larger, deeper staining nuclei.

Fig. 4. Portion of perithecial wall showing at left inner nurse cells. In center chitinized cells and at right the looser outer hyphal cells.

PLATE 9. CATACAUMA FLABELLUM FROM PTERIS AQUILINA

Fig. 1. Portion of the host lying above a vascular bundle showing the hyphal elements of the fungus in epidermal, hypodermal, and pericycle cells. Note the heavy walled sclerenchyma cells in center surrounded by

epidermis above, parenchyma at sides, with pericycle and endodermis below.

Fig. 2. Section of fungous stroma lying between epidermis and sclerenchyma. Note that the hypodermal layer is the one which is chiefly disorganized and broken. The epidermal cells contain the hyphae which together with abundant infiltration products (not shown) make up the so-called clypeus. The sclerenchyma cells beneath are tightly packed with the irregular hyphal elements.

Fig. 3. The same. Two adjacent giant cells showing multinucleated condition. Two nuclei in each of these cells are undergoing division.

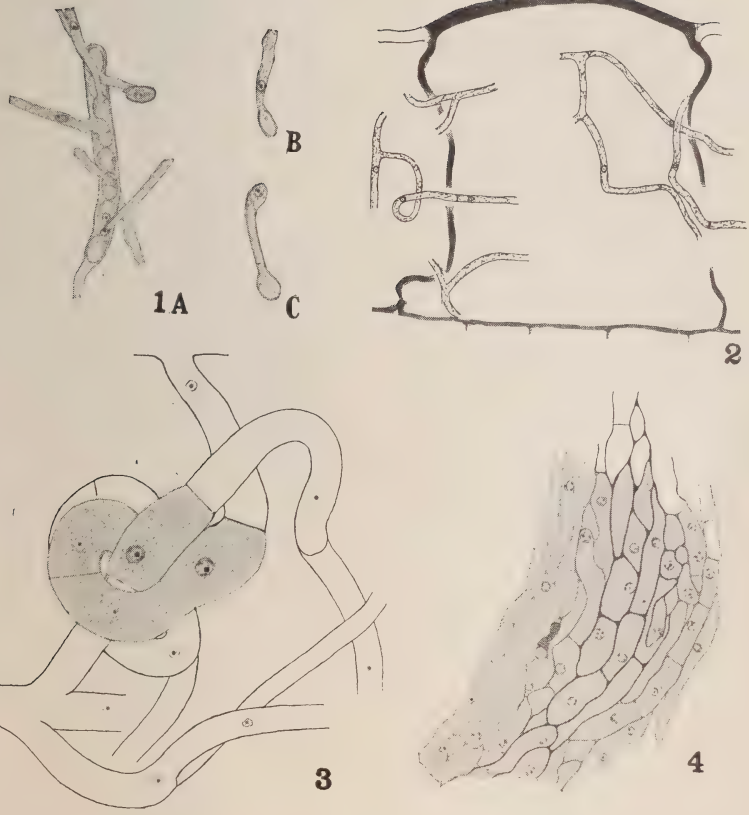
Fig. 4. The same. At left the rudimentary wall of an ascocarp bounded by the stroma on right.

BIBLIOGRAPHY

1. **Arnaud, G.** Les Asterinées. Ann. Ecol. Nation. Agric. Montpellier **16**: 1–288. 1918.
2. **Atkinson, G. F.** The genera *Balansia* and *Dothichloe* in the United States, etc. Jour. Myc. **11**: 248–267. 1905.
3. **Baccarini, P.** Appunti per la morfologia dello stroma nei Dotidacei. Ann. di Bot. **4**: 195–211. 1906.
4. **Bary, A. de.** Zur Kenntnis insectentödtender Pilze. Bot. Zeit. **25**: 1–7, 9–13, 17–21. 1867.
5. ——. Zur Kenntnis insectentödtender Pilze. Bot. Zeit. **27**: 585–593, 601–606. 1869.
6. ——. Morphologie und Biologie der Pilze. Leipzig. 1884.
7. **Beach, W. S.** The lettuce drop due to *Sclerotinia minor*. Penna. Agr. Exp. Sta. Bull. **165**: 1–27. 1921.
8. **Berkeley, M. J.** Introduction to Cryptogamic Botany, London. 279–280. 1857.
9. **Biffen, R. H.** On the biology of *Bulgaria polymorpha* Wetts. Ann. Bot. **15**: 119–134. 1901.
10. **Blackman, V. H. and E. J. Welsford.** The development of the perithecium in *Polystigma rubrum*. Ann. Bot. **26**: 761–767. 1912.
11. **Boudier, E.** Bull. Soc. Mycol. Fr. **1**: 115. 1885.
12. ——. Hist. Class. Discomy. Eur. Paris 1–221. 1907.
13. **Brefeld, O.** Basidiomyceten III. Unters. Gesammt. Mykol. **8**: 1–305. 1889.
14. ——. Ascomyceten II. Unters. Gesammt. Mykol. **10**: 157–378. 1891.
15. **Butler, E. J.** Fungi and Disease in Plants. Calcutta. 1918.
16. **Cesati, V. and G. de Notaris.** Schema di Class. Sferiacei ital. aschigeri, etc. Comment Soc. Crittogam. Ital. **1**: 177–240. 1863.
17. **Chardon, C. E.** A contribution to our knowledge of the pyrenomycetes of Porto Rico. Mycologia **13**: 279–300. 1921.
18. **Claussen, P.** Zur Entwickelungsgeschichte der Ascomyceten, Boudiera. Bot. Zeit. **53**: 1–27. 1905.
19. **Dalbey, Nora E.** *Phyllachora* as a cause of disease in corn, etc. Trans. Ill. Acad. Sci. **10**: 230–248. 1917.
20. **Dawson, Maria.** On the biology of *Poronia punctata* (L.) Willd. Ann. Bot. **14**: 245–262. 1900.

21. **Doidge, E. M.** *Meliolaster,* a new genus of the Microthyriaceae. Trans. Roy. Soc. So. Africa **8**: 121–123. 1920.
22. ——. South African Ascomycetes in the National Herbarium. Bothalia **1**: 5–32, 65–82. 1922.
23. **Ellis, J. B. and B. M. Everhart.** The North Am. Pyrenomycetes, p. 1–1892.
24. **Fink, B.** The Ascomycetes of Ohio. Ohio Biol. Survey **2**: 1–30. 1915.
25. **Fisch, C.** Beitrage zur Entwickelungsgeschichte einiger Ascomyceten. Bot. Zeit. **40**: 851–869, 875–906. 1882.
26. **Fries, E.** Obs. Myc. 2: 347–451. 1818.
27. ——. Syst. Myc. **2**: 313, 548–565. 1823.
28. **Fuckel, L.** Symb. Myc. 75–343. 1869.
29. **Fuisting, W.** Zur Entwickelungsgeschichte der Pyrenomycetes. Bot. Zeit. **25**: 177–181, 185–189, 193–198, 305–311. 1867.
30. ——. Zur Entwickelungsgeschichte der Pyrenomycetes. Bot. Zeit. **26**: 369–375, 385–398, 401–407, 417–422. 1868.
31. **Goebel, K.** Class & Morph. Plants, p. 109. 1887.
32. **Godfrey, G. H.** Gray mold of castor bean. Jour. Agr. Res. **23**: 679–715. 1923.
33. **Gray, S. F.** Nat. Arr. Brit. Pl. **1**: 224. 1821.
34. **Harper, R. A.** Die Entwickelung des Peritheciums bei Sphaerotheca Castagnei. Ber. deutsch. bot. Gessell. **13**: 475–481. 1895.
35. ——. Sexual reproduction in *Pyronoma confluens.* Ann. Bot. **14**: 321–400. 1900.
35*a*. ——. Sexual reproduction, etc., in certain mildews. Carnegie Inst. Wash. Pub. **37**: 1–104. 1905.
36. **Hartig, R.** Der Fichtenriidenpilz, *Nectria cucurbitula* Fries. Unters. forstbot. Inst. München **1**: 63– . 1880.
37. ——. Der Krebspilz der Laubhalzbäume, *Nectria ditissima* Tul. Unters. forstbot. Inst. München **1**: 109–128. 1880.
38. **Höhnel, Fr. von.** Fragmente zur Mykologie. Sitz. d. Kaiser. Akad. Wissenschaft. Wein **118**: 275, 452, 813–904, 1157–1246, 1461–1552. 1909
39. ——. Fragmente zur Mykologie. Sitz. d. Kaiser. Akad. Wissenschaft. Wein **119**: 393–473, 617–679, 877–958. 1910.
40. **Jaczewski, A. de.** Essai de Classification Naturelle des Pyrenomycetes. Bull. Soc. Myc. France **10**: 13–48. 1894.
41. **Janczewski, E.** Morphologische Untersuchungen über *Ascobolus furfuraceus.* Bot. Zeit. **29**: 257–262, 271–278. 1871.
42. **Janowitsch, A.** Uber die Entwickelung der Fructifikationsorgane von *Nectria.* Bot. Zeit. **23**: 149–153. 1865.
43. **Killian, Charles.** Morphologie, Biologie und Entwicklungsgeschichte von *Cryptomyces Pteridis* (Rebent.). Rehm. Zeitschrf. Bot. **10**: 49–126. 1918.
44. ——. Le developpment du *Dothidella Ulmi* (Duv.) Wint. Rev. Gen. Bot. **32**: 534–551. Pl. 16–19; fig. 1–18. 1920.
45. **Leveillé, J. H.** Consid. Mycol. 118–120. 1846.

46. **Lewton-Brain, L.** *Cordyceps ophioglossoides.* Ann. Bot. **15:** 521–531. 1901.
47. **Lindau, G.** Pezizineae, Phacidiineae, Hysteriineae. *In* Engler & Prantl Pflanzenf. 1^1: 231–278. 1896.
48. ——. Pyrenomycetineae. *In* Engler & Prantl Pflanzenf. 1^1: 321–491. 1897.
49. ——. Dothideales. *In* Engler & Prantl Pflanzenf. 1^1: 373–374. 1897.
50. **Lupo, Patsy.** Stroma and formation of perithecia in *Hypoxylon.* Bot. Gaz. **73:** 486–495. 1922.
51. **Maire, R.** Remarques sur quelque Hypocréacées. Ann. Myc. **9:** 315–325. 1911.
52. **Massee, G.** A revision of the genus *Cordyceps.* Ann. Bot. **9:** 1–44. 1895.
53. **Muller, J.** Zur Kenntnis des Runzelschorfes und der ihm ähnlichen Pilz. Prings. Jähr. f. Wiss. Bot. **25:** 605–627. 1893.
54. **Nitschke, Th.** Pyren. germ. 1: 1–320. 1867.
55. **Overton, J. B.** The morphology of the ascocarp and spore formation in the many spored asci of *Thecotheus Pelletieri.* Bot. Gaz. **42:** 450–492. 1906.
56. **Persoon, C. H.** Obs. Myc. p. 18. 1796.
57. ——. Tent. disp. method. fung., p. 1–76. 1797.
58. ——. Synop. Method. Fung. X. 1801.
59. **Pfeiffer, L.** Nomen. bot. 1: and 2: 1873–1874.
60. **Ruhland, W.** Untersuchungen zu einer morphologie der stromabilden den Sphaeriales. Hedwigia **39:** 1–79. 1900.
61. ——. Uber die Ernahrung und Entwickelung eines mycophthoren Pilze *Hypocrea fungicola* Karst. Verh. Bot. Ver. Prov. Brand. **42:** 53–65. 1900.
62. **Seaver, F. J.** The Hypocreales of North America I. Mycologia 1: 41–76. 1909.
63. —— **and W. T. Horne.** Life history of *Sclerotinia.* Mem. Torr. Club. **17:** 202–206. 1917.
64. **Shear, C. L. and B. O. Dodge.** The life history and identity of *Patellina Fragariae, Leptothyrium macrothecium* and *Peziza Oenotherae.* Mycologia **13:** 135–170. 1921.
65. **Smith, R. E.** *Botrytis* and *Sclerotinia.* Bot. Gaz. **29:** 369–407. 1900.
66. **Stevens, F. L.** Spegazzinian *Meliola* types. Bot. Gaz. **64:** 421–425. 1917.
67. **Tavel, F. von.** Vergleich. Morph. Pilze. Jena 1892.
68. **Thaxter, Roland.** Note on the ascoporic condition of the genus *Aschersonia* Mont. Bot. Gaz. **57:** 308–313. 1914.
69. **Theissen, F.** Uber Membranstructuren bei den Microthyriaceen als Grundlage fur den Ausbau der Hemisphaeriales. Mycol. Centralb. 3: 273–286. 1913.
70. ——. *Lembosia*-Studien. Ann. Myc. 11: 425–467. 1913.
71. ——. Hemisphaeriales. Ann. Myc. 11: 468–469. 1913.
72. ——. Trichopeltaceae n. fam. Hemisphaerialium. Centralb. f. Bakt. Par. II; **39:** 625–640. 1914.



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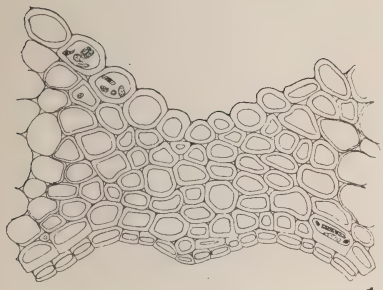

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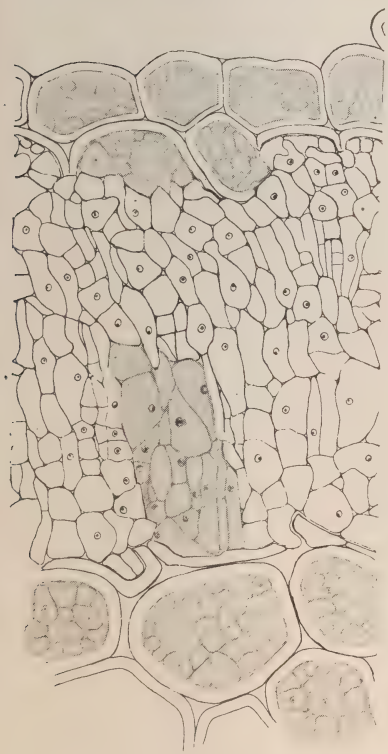

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CATACAUMA FLABELLUM FROM PTERIS AQUILINA

73. **Theissen, F., and H. Sydow.** Die Dothideales. Ann. Myc. 13: 149–746. 1915.
74. **Tode, H. J.** Fungi Mecklenb. sel. fasc. 1: 2. 1790.
75. **Traverso, G. B.** La nomenclatura degli organi nella descrizione dei pirenomiceti e deuteromiceti. Nuovo Giorn. Bot. Ital. 12: 261–280. 1905.
76. **Tulasne, L. R.** Mem. sur l'Ergot des Glumacées. Ann. Sci. Nat. III, 20: 5–56. 1853.
77. **Tulasne, L. R. and C.** Selecta Fung. Carp. 2: 1–319. 1863.
78. ——. Selecta Fung. Carp. 3: 1–221. 1865.
79. **Vincens, F.** Le *Cordyceps Sphingum,* etc. Bull. Soc. Pathol. Vegetal. France 2: ——. 1915.
80. ——. Recerches organogéniques sur quelques Hypocreales. Thése. Paris. 1–170. 1917.
81. **Vuillemin, Paul.** Les Champignons. Encycl. Sci. Paris. 1912.
82. **Ward, H. M.** Researches on the morphology and life history of a tropical pyrenomycetous fungus. Quart. Jour. Micr. Sci. 22: 347–354. 1882.
83. **Winter, G.** Ascomyceten. Rab. Krypt. Flora 1^2: 1–928. 1887.
84. **Wollenweber, H. W.** Studies on the *Fusarium* problem. Phytopath. 3: 24–50. 1913.
85. **Woronin, M.** Uber die Sclerotienkrankheit der Vaccinieen-Beeren. Mem. l'Acad. Imp. Sci. St. Petersb. VII; 36: No. 6. 1–49. 1887.
86. ——. Die Sclerotienkrankheit der Gemeinen Trauben-Kirsche und des Eberesche. Mem. l'Acad. Imp. Sci. St. Petersb. VIII; 2: No. 1. 1–27. 1895.
87. ——. Uber *Sclerotinia cinerea* und *Sclerotinia fructigena.* Mem. l'Acad. Imp. Sci. St. Petersb. VIII; 10: No. 5. 1–38. 1900.
88. **Woronin, M. and S. Nawaschin.** *Sclerotinia heteroica.* Zeitschr. f. Pflanzenkr. 6: 129–140, 199–207. 1896.

NOTES AND BRIEF ARTICLES

(Unsigned notes are by the editor)

Lake Placid Fungi

The fungi listed below were found in the Lake Placid region, October 19–25, 1923, while the writer was enjoying a brief vacation at the Lake Placid Club. On a previous visit in October some years ago, the ground was covered with a light snow but the weather last fall was sunny and rather warm during the day with several frosty nights. The first frost of the season dated back to August 15. For a brief popular account of the vegetation in general at Lake Placid, the reader is referred to an article contributed to the current volume of the *Journal of the New York Botanical Garden.*

Puffballs were rather scarce, only three species being found, the commonest being *Lycoperdon gemmatum.* The cup-fungi were represented by *Helotium citrinum,* a late species; the slime-molds by *Lycogala epidendrum;* the gelatinous fungi by *Exidia arborea* and *Dacryomyces aurantia;* and the semi-gelatinous forms by *Merulius tremellosus,* seen in abundance on a sugar maple stump. Resupinate forms were common, especially on the underside of logs and fallen branches, where they were protected by the warmth of the earth. Several species of *Stereum, Hymenochaete, Corticium,* and the other Thelephoraceae were found on dead wood, as well as resupinate polypores. *Fuscoporia ferruginosa* was frequently seen, and *Fomitiporia prunicola* was common on dead trunks of Pennsylvania cherry trees that had been killed by it.

This region is an excellent one for polypores, because of the immense amount of fallen timber of various kinds and the prevailing moist conditions. Many of the living trees bear large brackets and without doubt considerable damage is done by the tree-destroying species. *Pyropolyporus igniarius,* for example, was abundant on birch, beech, elm, maple, hop hornbean, and other

hardwood trees. *Elfvingia megaloma* attacked a wide variety of hardwood trees—even cottonwood—and formed brackets reaching two feet in diameter. Coniferous trees were found attacked by the thin forms of *Porodaedalea Pini* and *Fomes roseus,* and the hoof-shaped *Fomes ungulatus. Coltricia tomentosa, Coriolus abietinus,* and *Gloeophyllum hirsutum* were also found on coniferous wood; and *Tyromyces chioneus, Irpiciporus lacteus, Polyporus Polyporus, Bjerkandera adusta, Daedalea confragosa,* and several species of *Coriolus* on hardwood. *Coriolus versicolor* and *C. pubescens* were more common than *C. prolificans* and *C. nigromarginatus.* The darker, zoned form of *C. pubescens,* which is the typical European form, was common on dead aspen and other hardwoods; while the white, scarcely zonate form with long hairs and long, thin-walled tubes was found once in dense masses on sugar maple.

The number of fleshy gill-fungi was undoubtedly much reduced by the unusual drought of the past season. Those I found were mostly in moss or thick humus in the dense shade of coniferous trees. Some appeared to be summer or early autumn species that were lingering into fall, but were neither abundant nor happy. Among these were: *Marasmius oreades, M. rotula, Laccaria laccata, Gymnopus dryophilus, Russula emetica, Cortinarius armillatus, Lactaria theiogala, Lactaria ocellata, Crepidotus mollis, Geopetalum abietinum, Gymnopilus penetrans, Hypholoma capnoides,* and *Paxillus involutus.* Others appeared to thrive under such conditions. *Gymnopus velutipes,* the winter mushroom, was in its glory but not common. *Chanterel aurantiacus* never appeared more beautiful than when growing fresh from coniferous stumps in the forests about the lake after a slight rain. *Omphalopsis campanella* appeared by the hundreds on balsam and spruce logs that were badly decayed. *Hypholoma sublateritium,* better known to Americans as *H. perplexum,* was not rare on dead hardwood timber; while *Crepidopus serotinus* appeared in conspicuous imbricate masses on living sugar maple trunks, and rarely on birch and certain other trees.

Moss-loving species that seemed to love frosty nights were: *Hygrophorus hypothejus, Chanterel muscoides* (*C. dichotomus*

Peck), *Lepiota amianthina, Cortinellus vaccinus,* and one or two species of *Cortinarius* that I have not yet determined. *Clitocybe dealbata* grew on the shaded borders of the golf links where I had seen it frequently before; but I was surprised to find large masses of a species similar in appearance, habit, and habitat, although very much larger and more abundant, growing in the grass in several places about the old summer hotel. When I find the time to study it, this may prove to be a very interesting species.

W. A. MURRILL

The fifteenth annual meeting of the American Phytopathological Society was held at Cincinnati, Ohio, December 27–January 1, 1924. The following abstracts of papers presented are copied from those published in advance of the meeting.

Chestnut blight in Europe (*Endothia parasitica* (*Murr.*) *A. & A.*). HAVEN METCALF.

The occurrence of chestnut blight at Bruges, Belgium, is reported. It is believed that this is the first report of this disease in Europe. In London a chestnut staging-pole was observed with a blight canker on it, but the fungus was dead. The theory is advanced that the chestnut blight may have been taken to Europe from America on chestnut poles or other chestnut timber during the war.

Fungous diseases of the China aster. W. O. GLOYER.

The following parasitic fungi on the China aster were studied: *Ascochyta asteris* (=*Phyllosticta asteris* Bres.), *Botrytis cinerea, Coleosporium solidaginis, Fusarium sp., Phytophthora sp., Rhizoctonia solani* and *Septoria callistephi.* The leaf spots caused by Ascochyta, Botrytis, Coleosporium and Septoria were controlled by spraying with Bordeaux mixture. Ascochyta Botrytis, Fusarium and Septoria are seed borne and seed treatment with mercuric chloride proved more practical than spraying the plants. Botrytis, Fusarium, Rhizoctonia and Septoria may cause damping off and stem rot. Septoria is viable on two-year-old seed. As Septoria and other fungi winter on the stalks, they should be burned. Asters are susceptible to the other diseases studied during the seedling and seed producing periods, but the plants are attacked by Fusarium and Septoria at any period of their growth.

Poria cocus developed on tuckahoe found attached to orange tree root. GEORGE F. WEBER.

Several tuckahoes were found, in June, 1923, attached to the roots of an orange tree near Gainesville, Florida. They varied in weight from 5 to 9 pounds and were irregular in shape. The outside covering was bark-like, brown and tough. It varied from 3 to 8 mm. in thickness. The inner texture was white, starchy, spongy and gave off a mushroom odor. One of these bodies was sterilized for twenty minutes in a 1–1000 solution of corrosive sublimate. It was then carefully washed in five changes of sterile distilled water and placed in a sterile moist chamber at room temperature exposed to intermittent light. After ten days a chocolate-brown fungus growth appeared in several places on the outside covering, this growth matted down and fruiting structures developed of a resupinate nature apparently that of a Poria sp. The pores were irregular, 2 to 4 mm. deep, and of a distinct chocolate-brown color. The basidiospores were greyish white $6–9 \times 2–4\,\mu$.

The grey bulb-rot of tulips. H. H. WHETZEL AND JOHN M. ARTHUR.

This disease long known in Holland and Germany as the sclerotium disease of tulips is here reported apparently for the first time from America. The identity of the pathogene with the fungus described by Klebahn as *Sclerotium tuliparum* has been established. A critical study of the fungus indicates that it is a Rhizoctonia rather than a Sclerotinia as suggested by Klebahn. The organism is therefore transferred to the former genus under the name *Rhizoctonia tuliparum* (Klebahn) nov. comb. No perfect stage has been discovered.

Soil disinfection experiments made in October, 1923, indicate that the fungus may be effectively eradicated from infested soil by the application of formaldehyde solution at the rate of 1 lb. (40 per cent.) formalin per 5 square feet of soil surface. The drench used was made up at the rate of one part formalin to fifty parts water and was applied 12 plates by variations in the rate of growth, production of conidia and aerial hyphae, and shape and elevation of the colony.

Two bacterial diseases of gladiolus. LUCIA MCCULLOCH.

An undescribed leaf blight, particularly destructive to young stock, has been found on several varieties of gladiolus. The spots are translucent, usually angular, water-soaked, dark green, becoming brown. From these lesions there is a copious bacterial exudate in which soil particles become imbedded.

The organism, which produces a yellow, viscid growth on culture media, has been isolated repeatedly, its characters studied and its pathogenicity proved. The group number is 211.2322523. The name proposed for this organism is *Bacterium gummisudans*. A complete description of this disease has been submitted for publication.

The other disease, caused by *Bacterium marginatum* L. McC., was re-

ported briefly in Science, August 5, 1921, as a rot occurring at the base of gladiolus leaves. Further study demonstrated that this organism is also the cause of a characteristic disease of gladiolus corms. Husk lesions are brown to black, causing holes or cracks. On the body of the corm the spots are circular, depressed areas, yellow to brown, horny in texture, easily removed, leaving clean saucer-shaped pits. In these lesions of husk and corm the bacteria remain viable and pathogenic from season to season, thus providing a source of infection wherever the diseased corms are planted.

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VOL. XVI MAY, 1924 NO. 3

THE GENUS FRACCHIAEA[1]

HARRY MORTON FITZPATRICK

(WITH PLATE 10)

As originally delimited the genus *Fracchiaea* Saccardo consisted of the single newly described species, *Fr. heterogenea* Sacc., based on several collections of material made on branches of *Acer, Aesculus, Buxus, Lonicera,* and *Rhamnus* in Italy. Later a few species previously placed in *Sphaeria* were transfered to *Fracchiaea,* and a number of new species were described. A total of twenty-two species and six varieties have been listed in Saccardo's Sylloge Fungorum, and two[2] additional forms, a species and a variety, have been named. The genus has not been critically studied. The only general treatment of the group is that of Berlese (4).

Since the perithecium in several of the species is strikingly similar in form and structure to that of *Nitschkia* the present investigation was undertaken in the endeavor to determine whether these two genera are in reality closely related. In the writer's monographic study of the Nitschkieae (12) *Fracchiaea* is said to be "apparently not widely separated from the group."

During the past year through the courteous coöperation of a number of mycologists[3] in this country and abroad it has been

[1] The investigation upon which the article is based was in part supported by a grant from the Heckscher Foundation for the Advancement of Research established by August Heckscher at Cornell University.

[2] *Fr. australis* Spegazzini in herb. and *Fr. heterogenea v. aculeata* v. Höhnel in herb. for which no published descriptions have been seen.

[3] The herbaria of the New York Botanical Garden, Harvard University, and the Bureau of Plant Industry have been visited, and all the material of *Fracchiaea* available at these institutions and at Cornell University has been

[MYCOLOGIA for March 16: 49–100) appeared March 31, 1924]

possible to examine and compare the type specimens of practically all the species which have been referred to the genus. It is now evident that *Fracchiaea* must be incorporated in the Nitschkieae. It differs from the other genera of the group only in that the asci are polysporous and in the non-cupulate aspect of the perithecia. In all other essential respects the agreement is marked. The genus is here treated, therefore, as a member of the Nitschkieae, attention being called to the fact that although the cupulate form of the perithecium, so characteristic of the other members of the group, is not usually assumed, it has been observed in a few collections.

A comparative study of material representing various species of the genus reveals that a diversity of forms has been included. Of the thirty species and varieties which have been established ten are here definitely excluded from the genus, and four, material of which is unavailable, remain as doubtful. The facts concerning each case are discussed below under the heading "doubtful and excluded forms." Some of these species have little in common except the polysporous nature of their asci. One, *Fr. microspora,* is a discomycete.

The remaining sixteen species and varieties are recognized as belonging to the genus, but the conclusion has been reached that they should all be merged as one species. The genus as here considered is consequently monotypic. In view of the fact that Berlese (4) has recognized the majority of these forms as distinct species, the facts which indicate that they are identical will be emphasized.

In an examination of material representing the various forms a striking similarity is at once noted. The most characteristic structure is the ascus. It is somewhat variable in shape and size, but the oblique arrangement of the overlapping spores in parallel series is the same in all cases. The spores vary slightly in length in different collections but the differences do not afford a tangible basis for separation of species. The perithecium in external aspect is

examined. The writer wishes to express his appreciation of the privileges accorded him by the curators of these herbaria, and to thank those individuals who have mailed specimens for examination.

distinctive, the habit being the same, and the spines [4] being characteristic. An examination of the figures published by Berlese (4) reveals many points of apparent difference in the various species, especially with reference to the aspect of the perithecium in longitudinal section. As pictured by him the perithecium of *Fr. pauridia* is seated directly on the substratum, is wholly devoid of stromatic tissue, and in form is sub-globose instead of turbinate. In *Fr. eucalyptina* it is shown to be smooth while in *Fr. brevibarbata* it is covered with prominent warts or spines. The ascus of *Fr. brevibarbata* is pictured as long-stalked, and is said to differ in this respect from that of *Fr. heterogenea.* These features and others including differences in measurements of perithecia, asci, and spores constitute the bases for separation of the species recognized. In the endeavor to verify Berlese's observations a critical study of type specimens and other collections of material has been made. The differences indicated have either been found to be wholly lacking or to be so inconstant or intangible as to be worthless as characters for the separation of species. Moreover, no other characters have been brought to light which can be so used.

SYSTEMATIC ACCOUNT

FRACCHIAEA Saccardo Atti Soc. Veneto-Trentina Sci. Nat. 2: 163–164. *pl. 12. fig. 3–7.* 1873 (in honor Joseph Fracchia).

Type species, *Fracchiaea heterogenea* Sacc.

Perithecia black, coriaceous-carbonaceous, turbinate, cespitose on a pseudoparenchymatous stroma, erumpent, characteristically spiny, apically obscurely ostiolate, only rarely collapsing to cupulate, the basal portion solid and pseudoparenchymatous, the terminal portion enclosing a subspheric ascigerous cavity; asci thin-walled but not strikingly evanescent, polysporous, clavate, narrowed below, sometimes long-stipitate; ascospores allantoid, slightly curved, arranged obliquely in the ascus in several longitudinal rows, more or less clearly centrally uni-septate, hyaline, yellowish in the ascus.

[4] In European collections the spines are less commonly provided with secondary barbs than is the case in North American specimens. In two South American collections the tips of the spines are sometimes forked.

Probably most closely allied to *Calyculosphaeria,* but in the presence of perithecial spines also recalling *Acanthonitschkea.*

1. FRACCHIAEA HETEROGENEA Sacc., Mycol. Ven. Spec. Atti Soc. Veneto-Trentina Scienze Nat. **2**: 163. 1873.

? *Sphaeria rasa* Berkeley, in Hooker, Flora New Zealand **2**: 205. 1855.

Sphaeria subcongregata Berk. & Curt. nom. nud., in Rav. F. Carol. **4**: *57.* 1855.

Sphaeria brevibarbata Berk. & Curt., nom. nud. in Herb. Berk.

Cucurbitaria brevibarbata Berk & Curt., Grevillea **4**: 47. 1876.

Sphaeria subconnata Berk. & Curt., Grevillea **4**: 141. 1876.

Gibbera moricarpa Cooke, Grevillea **7**: 51. 1878.

Fracchiaea cucurbitarioides Speg., F. Argent. **2**: 21. 1880.

Coelosphaeria subconnata (Berk. & Curt.) Sacc., Syll. Fung. **1**: 93. 1882.

Fracchiaea brevibarbata (Berk. & Curt.) Sacc., Syll. Fung. **1**: 94. 1882.

Fracchiaea moricarpa (Cooke) Sacc., Syll. Fung. **1**: 94. 1882.

? *Fracchiaea rasa* (Berk.) Sacc., Syll. Fung. **1**: 95. 1882.

Sphaeria subconvexa Berk. & Rav. nom. nud., in Cooke, Grevillea **15**: 83. 1887.

Fracchiaea subconnata (Berk. & Curt.) Cooke, Grevillea **15**: 83. 1887.

Fracchiaea americana Berlese, Fungi Moricolae Fasc. 5. No. 1. 1888.

Fracchiaea glomerata Patouillard, Jour. de Bot. **3**: 168. 1889.

Sphaeria pauridia Berk. & Curt. nom. nud. in Herb. Curtis.

Nitschkia pauridia Cooke, Grevillea **20**: 107. 1892.

Fracchiaea subcongregata (Berk. & Curt.) E. & E., North Amer. Pyren. 244. 1892.

Nitschkia subconnata (Berk. & Curt.) Kuntze, Rev. Gen. **3²**: 501. 1898.

Fracchiaea pauridia (Berk. & Curt.) Berlese, Icon. Fung. **3**: 25. 1900.

Fracchiaea eucalyptina Berlese, Icon. Fung. **3**: 27. 1900.

Fracchiaea cucurbitarioides f. *eucalyptina* (Berl.) Speg. Ann. Mus. Nac. Buenos Aires **19**: 333. 1909.

Fracchiaea cucurbitarioides f. *Pini-insignis* Speg., Ann. Mus. Nac. Buenos Aires **19**: 333. 1909.

Fracchiaea cucurbitarioides f. *Quercus-sessiliflorae* Speg. Ann. Mus. Nac. Buenos Aires **19**: 334. 1909.

Fracchiaea cucurbitarioides f. *cecropiicola* Speg. nom. nud. in Herb. Speg.

Fracchiaea heterogenea v. *aculeata* v. Höhnel. nom. nud. in Herb. v. Höhnel.

ILLUSTRATIONS: Berl. Ic. Fung. **3**: *pl. 31–35;* Berl. Fung. Moricolae fasc. 5. *pl. 15. fig. 1–6;* Sacc. Myc. Ven. Spec. **2**: *pl. 12. figs. 4–17.*

(Figures 1–4)

Perithecia erumpent through crevices in the bark, cespitose, forming pulvinate, hemispheric to more or less elongated or irregular groups 1–10 mm. in diameter containing usually 5–30 but sometimes as many as 100 individuals, borne on a relatively inconspicuous though well developed pseudoparenchymatous stroma from which brown, septate hyphae 3.5–6 μ in diameter penetrate into the wood, black, dull to shiny, prominently spiny, turbinate, often irregular from lateral pressure, 350–650 μ in diameter, provided at the apex with a somewhat obscure papilliform ostiolum, sometimes becoming umbilicate, rarely collapsing to definitely cupulate, in section strikingly resembling the perithecia of *Nitschkia* in form and cellular structure; perithecial spines numerous, attaining 25 μ in length, approximately 10 μ in diameter at the base, tapering uniformly to the sharp-pointed tip, usually provided with secondary barbs which are progressively larger toward the base of the primary spine, black, opaque, in some cases apically forked; asci clavate, thin-walled, polysporous, rounded at the apex, narrowed toward the base which is often very long-stipitate, 50–95 x 14–27 μ (p. sp.); spores allantoid, slightly curved, somewhat narrowed toward the rounded ends, hyaline, but in mass in the ascus distinctly yellowish, usually provided at each end with a single small bright refractive globule and at the center with a more or less definite transverse septum, arranged characteristically in the ascus in several longitudinal rows, each spore lying obliquely with its lower end toward the ascus wall and with its upper end toward the interior, 6–11 x 1.5–2 μ (mostly 8–9 x 1.5 μ).

Apparently cosmopolitan in distribution. Known from North America, South America, and Europe. Collected on *Rhamnus,*

Aesculus, Buxus, Lonicera, Rubus, Alnus, Eucalyptus, Myrica, Morus, Quercus, Pinus, and other plants.

Although the type material and original description of *Sphaeria rasa* Berkeley have been studied the writer is still in doubt as to the identity of this species. It is included in the above synonymy chiefly on the basis of Berlese's figures.

MATERIAL EXAMINED

Berkeley Herb., Kew. (*type* material of *Sph. subconnata,* 2737 ex Rav. Herb); (*type* material of *Gibbera moricarpa,* 2471, 2540 ex. Rav. Herb.); (*type* material of *Sph. brevibarbata,* 1558, 1803 ex. Rav. Herb.).

Curtis Herb., Harvard Univ. (1413, *co-type* material of *Sph. pauridia*).

Saccardo Herb., in Herb. R. Horti Patavini (specimen collected in Italy on *Rubus* in 1878 and identified by Saccardo as *Fracchiaea heterogenea*).

Ellis Herb., N. Y. Bot. Gard. (specimen ex Herb. A. P. Morgan 1210, collected in Ohio by Morgan and labelled *Fr. brevibarbata*); (specimen ex Herb. Ravenel, collected by Ravenel at Darien, Georgia, on *Myrica* and apparently *co-type* material of *Gibbera moricarpa*) (137 collected at Malaga, New Jersey on *Morus* and apparently *co-type* material of *Fr. americana:* published by Cooke and Ellis as *Sph. botryosa*).

Billings Herb., N. Y. Bot. Gard. (specimen ex Herb. Rav., apparently same collection as Rav. Fung. Car. 4:57, labelled *Sph. subcongregata*).

Patouillard Herb., Paris, *type* material of *Fr. glomerata.*

v. Höhnel Herb. Harvard Univ. (specimen labelled *Fr. heterogenea* v. *aculeata* v. Höhnel) (five prepared slides labelled "*Fr. heterogena* Sacc. orig. ex. Myc. Ven. 88." This seems to be an erroneous citation).

Spegazzini Herb., Argentina (*type* material of *Fr. cucurbitarioides* on *Erythrine*); (*type* material *Fr. cucurbitarioides* f. *Pini-insignis* on *Pinus insignis*); (type material of *Fr. cucurbitarioides* f. *Quercus-sessiliflorae* on *Quercus-sessiliflora*); (type material of *Fr. cucurbitarioides* f. *Cecropiicoli* on *Cecropos adenopus*).

Fitzpatrick Herb., Cornell Univ. (1901 collected by R. Thaxter in Argentina on *Eucalyptus*: material of same deposited in Herb. Thaxter, Cambridge, Mass.).

Spegazzini, Dec. Myc. Argentinae 41, distributed as *Fr. heterogenea* and later made the basis of *Fr. eucalyptina* (at N. Y. Bot. Gard., Harvard Univ., Bur. Plant Industry, and in Saccardo Herb.).

Cavara, Longobardiae Exsiccati 119, labelled *Fr. heterogenea* (at N. Y. Bot. Gard., Harvard Univ., and Bur. Plant Industry).

Ravenel Fungi Car. **4**: 57, distributed as the original material of *Sphaeria subcongregata* (at N. Y. Bot. Gard., Harvard Univ., Cornell Univ., Bur. Plant Industry, and Herb. Berkeley).

Langlois, Flora Ludoviciana 2469, distributed as *Fr. subcongregata* (at N. Y. Bot. Gard., and Bur. Plant Industry).

Herb. U. S. North Pacific Exploring Expedition under Commanders Ringgold and Rogers 1853–56, material collected by C. Wright in Nicaragua and determined by Ellis as *Sph. subcongregata* (at Harvard Univ., and Bur. Plant Industry).

Ellis, North Amer. Fung. 692, labelled *Gibbera moricarpa* (at N. Y. Bot. Gard., and Cornell Univ.).

Ravenel, Fungi Amer. 343, labelled *G. moricarpa* (at N. Y. Bot. Gard., Harvard Univ., Bur. Plant Industry, and Cornell Univ.).

DOUBTFUL AND EXCLUDED FORMS

As several of the species included under this heading are referred to genera of the Coronophoraceae a few remarks concerning this family should be incorporated here. The genera (*Coronophora* and *Cryptosphaerella* were first shown by von Höhnel (**14**, **15**) to differ essentially from the Calosphaeriaceae. He founded the family Coronophoraceae to include these two genera and later incorporated a new genus *Coronophorella*. The group as characterized by him includes forms in which a true ostiolum is lacking, the nucleus of asci being forcibly discharged as a whole through the perithecial wall so that a large, irregular opening remains. In *Cryptosphaerella* (polysporous) and *Coronophorella* (8-spored) this discharge follows the appearance within the perithecium of a prominent intrusion of gelatinized cells which hangs

as an inverted cone from the apex of the perithecium. This cone, evident in these genera, has not been observed in *Coronophora*. The genus *Fracchiaea* is regarded by v. Höhnel (**18, 19**) as closely related to these genera; differing from *Coronophora* according to him chiefly in the definite ascospore arrangement and in the possession of non-stipitate asci. He finds in the perithecium a typical ostiolar formation in the inner wall consisting of a circle of periphyses but fails to find a perforation through the outer wall. A conical intrusion of gelatinized cells is absent. This intrusion has been discovered by the writer in the perithecia of several species hitherto included in *Fracchiaea*. These species are here tentatively referred to *Cryptosphaerella*. Further work designed to elucidate their taxonomic relationships is in progress.

1. FRACCHIAEA CALLISTA (Berk. & Curt.) Sacc., Syll. Fung. **1**: 94. 1882.

Cucurbitaria callista Berk. & Curt., Grevillea **4**: 47. 1876.
Sphaeria callista Berk. & Curt. nom. nud. in Rav. Fung. Carol. **5**: 67. 1860.

Examination of the type material and other authentic specimens of this species reveals the presence of the above mentioned gelatinous intrusion and the absence of an ostiolum. The fungus showing the wide opening in the perithecial wall resulting from the forcible discharge of the nucleus is well illustrated in plate 10, figure 6. The species is a member of the Coronophoraceae and is here referred to *Cryptosphaerella*.

2. FRACCHIAEA AFFINIS Sydow, in Emile Wildeman, Flore Bas-Moy Congo **3**: 16. 1909.

Examination of type material from the herbarium of Sydow shows that in this species also an ostiolum is absent, and longitudinal sections reveal the presence of the conical gelatinous intrusion. The species is therefore referred to *Cryptosphaerella*.

3. FRACCHIAEA AUSTRALIS Spegazzini, in herb.

Study of the type material of this species shows it also to belong to *Cryptosphaerella*. A longitudinal section of the perithecium containing the gelatinous intrusion is shown in figure 5.

4. FRACCHIAEA ROMELLIANA Berlese, Icones Fungorum **3**: 26. *pl.* 32. *fig.* 3. 1900.

Coronophora gregaria (Lib.) Fuckel, in Herb. Romell.

Examination of type material from the herbarium of Berlese reveals the conical intrusion and the species is here referred to *Cryptosphaerella.*

5. FRACCHIAEA (?) MULTIASCA Patouillard, Bul. Soc. Mycol. Fr. **4**: 106. 1888.

An attempt was made to obtain type material of this species for study, but Professor Patouillard was unable to find the specimen in his herbarium. Apparently it has been lost. Since in the description of the species the contents of the perithecium are described as escaping as a whole, and since the perithecium is said to be astomous, we may suggest the probability that this species also is referable to *Cryptosphaerella.*

6. FRACCHIAEA ROSTRATA Delacroix, Bul. Soc. Mycol. Fr. **9**: 266. 1893.

Examination of type material, made available through the courtesy of Professor Patouillard, shows this species to differ very strikingly from *Fracchiaea.* The perithecium is prominently beaked, and the ascus contains a relatively small number of spores, probably 32, irregularly arranged. The characters of the species correspond in general to those figured by Berlese (**4**) for *Coronophora,* but it is not a member of this genus in the sense of von Höhnel (**15, 17**) and Petrak (**25**). The writer is inclined to refer it to *Valsella.*

7. FRACCHIAEA MICROSPORA Sacc. & Bresadola, Malpighia **13**: 437. 1899.

Examination of a portion of the type specimen of this species received from the herbarium of Saccardo reveals that the species is in fact a discomycete. Although the fruit-body has a superficial resemblance to a perithecium, thin sections reveal its true character. The paraphyses are very abundant, protrude beyond the asci, and at their tips are fused in a brown matrix forming an epithecium which is concolorous with the surface of the excipulum.

8. FRACCHIAEA INTROFLEXA Berk. & Rav. nom. nud. in Cooke, Grevillea **15**: 84. 1887.

Sphaeria introflexa Berk. & Rav. nom. nud. in herb. Curtis.

This species is merely *Tympanopsis euomphala* (Berk. & Curt.) Starbäck included by the writer (**12**) in the Nitschkieae.
kieae.

9. FRACCHIAEA CANDOLLEI (Tulasne) Cooke, Grevillea **15**: 84. 1887.

Pleurostoma Candollei Tulasne, Sel. Carpol. Fung. **2**: 247. *pl. 2. fig. 1–3.* 1863.

Cooke was in error in assuming that this species should be incorporated in *Fracchiaea.* It is a peculiar form of doubtful affinities. It was included by Lindau (**21**) in the Diatrypaceae. Berlese (**4**) supplies figures made from the type material, and apparently regards the species as related to *Neoarcangelia.* The writer has examined specimens in the herbarium of von Höhnel, and finds the species to be very unlike *Fracchiaea.*

10. SPHAERIA POLYCOCCA Berk. & Rav. nom. nud. in Rav. Fung. Carol. **4**: 62. 1855.

This species is cited by Cooke (**6**) as equivalent to *Fracchiaea heterogenea* Sacc. Examination of three copies of this exsiccati (at Harvard Univ., N. Y. Bot. Gard., and Bur. Pl. Industry) shows the fungus present to be a *Eutypella.*

11. FRACCHIAEA CORDAEANA Schulzer & Sacc., Hedwigia **23**: 42. 1884, and Rev. Mycol. **6**: 68–69. 1884.

Synsphaeria parallela Schulzer, Verh. Zool.-Bot. Gesell. Wien. **21**: 1244. 1871.

12. FRACCHIAEA SACCARDIANA Schulz., in Schulz. & Sacc., Hedwigia **23**: 42. 1884, and Rev. Mycol. **6**: 69. 1884.

Synsphaeria parallela f. *acanthostigmoides* Schulzer, Verh. Zool.-Bot. Gesell. Wien. **21**: 1245. 1871.

Material of *Sphaeria parallela* Fries (**13**) was distributed by Fries (Scler. Suec. 3). Nitschke (**22**) examined three specimens of this in European herbaria, and compared them with other ma-

terial of the species identified by Fries. He found that the fungus has 8-spored asci, and brown, often 1-septate ascospores. He included it in *Valsa*. It was later placed in *Endoxyla* by Saccardo (28). The fungus has also been studied by the writer [5] and his findings agree with those of Nitschke. It is certainly not a *Fracchiaea*.

The fungi studied by Schulzer (30) from Slavonia, and described by him as *Synsphaeria parallela* and *Synsph. parallela* f. *acanthostigmoides* could not have been, as he thought, equivalent to *Sphaeria parallela* Fries, since he describes the asci as polysporous and the spores as hyaline and unicellular. This fact was later recognized, and the two fungi were redescribed by Schulzer and Saccardo (31) as *Fracchiaea Cordaeana* and *Fr. Saccardiana* respectively.

The writer has attempted to obtain authentic material of these species for study, but has been unsuccessful. They are not represented in the herbarium of Saccardo. In the library of the Hungarian Academy of Sciences at Budapest a voluminous, abundantly illustrated manuscript by Schulzer entitled "Schwämme und Pilze aus Ungarn und Slavonien" is preserved in five folio volumes, but is not accompanied by the specimens. The writer has been unable to learn whether these are still in existence. Moreover, a letter from Dr. G. Moesz, Director of the Department of Botany of the Academy, states that neither *Fr. Cordaeana* nor *Fr. Saccardiana* is mentioned or figured in the manuscript. Our knowledge of these species is limited, therefore, to the published descriptions cited above and the very inadequate figures which accompany them. As we cannot be sure that the forms are members of the genus it seems best to exclude them.

13. FRACCHIAEA HETEROGENEA f. ALNI Cavara, nom. nud. Fungi. Longobar. Exs. 234.

No material resembling *Fracchiaea* has been found by the writer in an examination of several copies of this exsiccati number. According to Berlese (4) and v. Höhnel (19) the fungus distributed is *Ditopella fusispora*.

[5] Scler. Suec. 3, at Harvard Univ. and Bur. Plant Industry.

14. FRACCHIAEA HETEROGENEA f. SALICIS Sacc., in Berlese, Icon. Fung. 3: 26–27. *pl. 34. fig. 1.* 1900.

Berlese does not figure the ascus and spores, and his drawing of the perithecia and very brief description leave us in doubt as to the identity of this form.

15. SPHAERIA BOTRYOSA Fries, Syst. Mycol. 2: 342. 1823.

This species is included by Ellis (11) in his synonymy of *Fr. subcongregata*. An examination of material distributed by Fries (Scl. Suec. 122, at Harvard Univ.) shows a wholly different fungus.

16. FRACCHIAEA CONIFERARUM v. Höhnel, Sitzungsber. K. Akad. Wiss. Wien 118: 843–844. 1909.

The type material of this species (dried specimen and microscopic preparations) has been studied by the writer in the von Höhnel herbarium at Harvard University. The perithecia are definitely cupulate at maturity, a gelatinous intrusion is absent, and an ostiolum has not been demonstrated. The ascospores are not definitely arranged (i.e. "dachförmig gelagerten" acc. von Höhnel) and the asci are often long- and delicately-stipitate. The species is here excluded from *Fracchiaea* because of the shape of the perithecium which lacks entirely the turbinate form characteristic of the Nitschkieae and has a wall of approximately uniform diameter above and below. A stromatic tissue is absent. The species seems to be more closely allied to *Coronophora* than to *Fracchiaea*.

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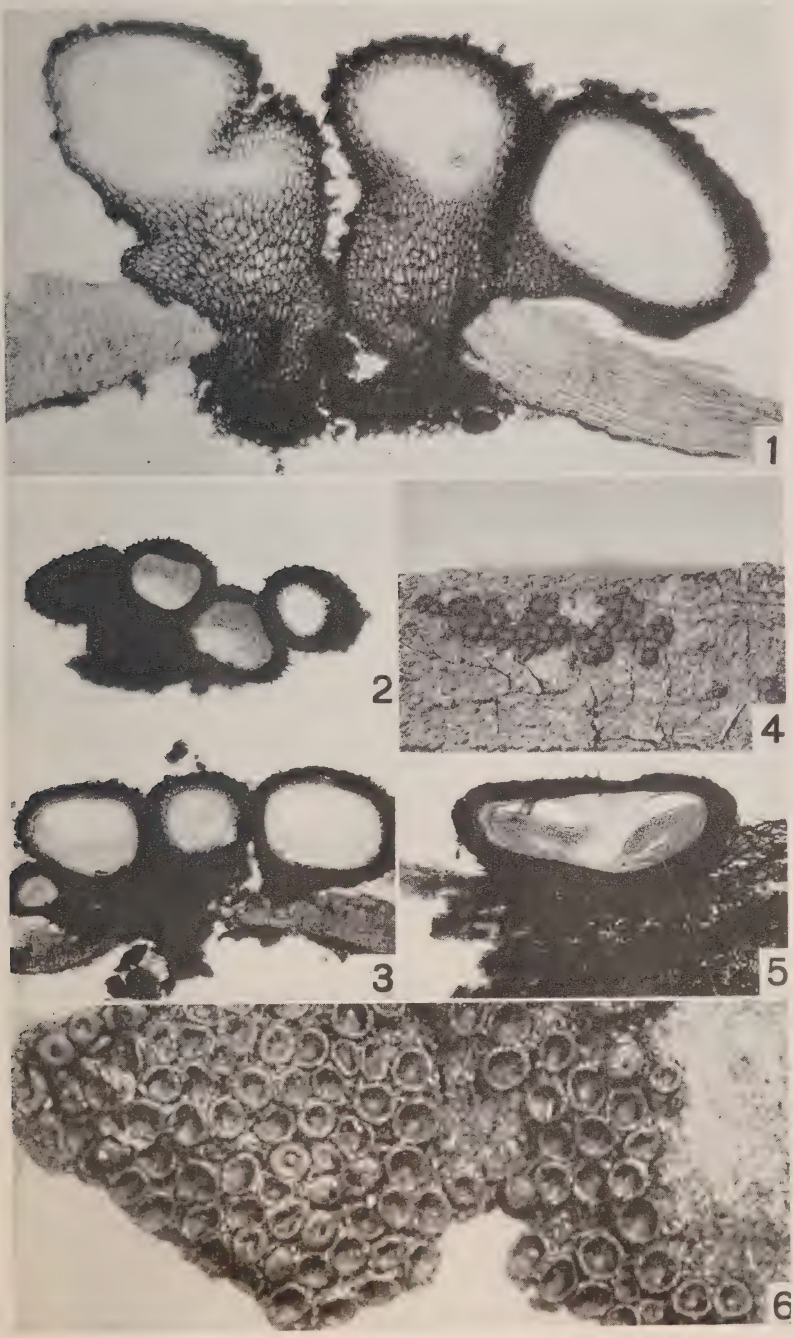
EXPLANATION OF PLATES

The magnifications given refer to the figures as reproduced. Leitz apochromatic objectives and compensating oculars were used. The photographs were taken by Mr. W. R. Fisher of the Department of Plant Pathology at Cornell University.

PLATE 10

Fig. 1. *Fracchiaea heterogenea.* Perithecia in longitudinal section. ×84. Material from Rav. F. Amer. 343 (= *Gibbera moricarpa*).

Fig. 2. *Fr. heterogenea.* Perithecia in longitudinal section. ×42. Material from Langlois Flora Ludoviciana 2469 (= *Fr. subcongregata*).



1–4. Fracchiaea heterogenea
5. Fracchiaea australis
6. Fracchiaea callista

Fig. 3. *Fr. heterogenea.* Perithecia in longitudinal section. ×42. Material from Spegazzini Myc. Argentinae 41 (= *Fr. eucalyptina*).

Fig. 4. *Fr. heterogenea.* Perithecia. ×6. Material from Langlois Flora Ludoviciana 2469 (= *Fr. subcongregata*).

Fig. 5. *Fr. australis.* Perithecium in longitudinal section showing conical gelatinous intrusion characteristic of *Coronophorella* and *Cryptosphaerella.* ×42. Type material.

Fig. 6. *Fr. callista.* Perithecia. ×16. Type material.

LITERATURE CITED

1. **Berkeley, M. J.** Fungi in J. D. Hooker Flora of New Zealand **2**: 205–206. 1855.
2. **Berkeley, M. J.** Notices of North American Fungi. Grevillea **4**: 47, 141. 1876.
3. **Berlese, A. N.** Fungi Moricolae, Fasc. **5**; No. 1 *pl. 1. figs. 1–5.* 1888.
4. **Berlese, A. N.** Icones fungorum **3**: 24–29. 1900.
5. **Cooke, M. C.** Ravenel's American Fungi. Grevillea **7**: 51. 1878.
6. **Cooke, M. C.** Synopsis Pyrenomycetum. Grevillea **15**: 83–84. 1887.
7. **Cooke, M. C.** Additional fungi descriptions. Grevillea **20**: 106–107. 1891.
8. **Cooke, M. C. and Ellis, J. B.** Some New Jersey fungi. Grevillea **4**: 178–180. *pl. 68.* 1876.
9. **Cooke, M. C. and Ellis, J. B.** New Jersey Fungi. Grevillea **5**: 93. 1877.
10. **Delacroix, G.** Travaux du laboratoire de pathologie vegetale. Bul. Soc. Mycol. Fr. **9**: 266. *pl. 14. fig. 6–7.* 1893.
11. **Ellis, J. B. and Everhart, B. M.** North American pyrenomycetes 244–245. 1892.
12. **Fitzpatrick, H. M.** Monograph of the Nitschkieae. Mycologia **15**: 23–67. *pl. 1–7.* 1923.
13. **Fries, Elias.** Systema mycologicum **2**: 342, 373. 1823.
14. **Höhnel, Franz v.** Fragmente zur Mykologie II. Sitzungsber. K. Akad. Wiss. Wien **115**: 661–666. 1906.
15. **Höhnel, Franz v.** Fragmente zur Mykologie IV. Sitzungsber. K. Akad. Wiss. Wien **116**: 624–630. 1907.
16. **Höhnel, Franz v.** Fragmente zur Mykologie VII. Sitzungsber. K. Akad. Wiss. Wien **118**: 843–844. 1909.
17. **Höhnel, Franz v.** Fragmente zur Mykologie IX. Sitzungsber. K. Akad. Wiss. Wien **118**: 1505–1508. 1909.
18. **Höhnel, Franz v.** Mykologisches XXIV Vorläufige Mitteilungen. Österr. Botan. Zeit. **66**: 54. 1916.
19. **Höhnel, Franz v.** Mykologische Fragmente. Ann. Mycol. **16**: 136–140. 1918.
20. **Kuntze, Otto.** Revisio generum plantarum 3^2: 501. 1898.
21. **Lindau, G.** Cucurbitariaceae, in Engler und Prantl, Die natürlichen, Pflanzenfamilien 1^1: 409. 1897.
22. **Nitschke, Th.** Pyrenomycetes Germanici 154. 1867.
23. **Patouillard, N.** Fragments Mycologiques. Jour. de Botan. **3**: 168. 1889.

24. **Patouillard, N. & Gaillard, A.** Champignons du Vénezuéla et principalement de la region du Haut-Orenoque recolles en 1887 par M. A. Gaillard. Bul. Soc. Mycol. Fr. **4**: 106. 1888.
25. **Petrak, F.** Mykologische Notizen. Ann. Mycol. **19**: 182–184. 1921.
26. **Rehm, H.** Beiträge zur Pilzflora von Südamerica XII. Sphaeriales. Hedwigia **40**: 100–124. 1901.
27. **Saccardo, P. A.** Mycologiae Venetae Specimen. Atti Società Veneto-Trentina Scienze Naturali **2**: 163–164. 1873.
28. **Saccardo, P. A.** Sylloge Fungorum **1**: 93–95. 1882; **9**: 445–447. 1891; **11**: 272. 1895; **16**: 418–419. 1902; **22**: 69–70. 1913.
29. **Saccardo, P. A. and Bresadola, G.** Enumerazione dei Funghi della Valsesia. Malpighia **13**: 437. *fig. II. 1 a–c.* 1899.
30. **Schulzer v. Müggenburg, Stefan.** Pilze an Quittenästen. Verh. Kais.-Konig. Zool.-bot. Gesell. Wien. **21**: 1244–1246. *pl. 10. fig. 24, 25.* 1871.
31. **Schulzer v. Müggenburg, Stefan and Saccardo, P. A.** Micromycetes Slavonici novi. Hedwigia **23**: 42. 1884; (same in Revue Mycol. **6**: 68–69. 1884).
32. **Schweinitz, L. D. de.** Synopsis Fungorum in America Boreali 206. 1832.
33. **Spegazzini, C.** Fungi Argentini 2. Anal. Soc. Ci. Argent. **9**: 21. 1880.
34. **Spegazzini, C.** Mycetes Argentinenses. Ann. Mus. Nac. Buenos Aires **19**: 333–334 1909.
35. **Tulasne, L. R. and Charles.** Selecta Carpologia Fungorum **2**: 247. *pl. 2. fig. 1–3.* 1863.
36. **Wildeman, Emile De.** Etudes de Systematiques et de Geographie Botaniques, in Flore du Bas-et du Moyen-Congo. Annales Musee Congo·Belge. Bot. ser. 5. **3**: 16–17. 1909.

A COLLECTION OF COSTA RICAN FUNGI

Silence Rowlee

(With Plates 11 and 12)

The fungi here listed were collected by W. W. Rowlee and H. E. Stork in Costa Rica during July and August of 1920. The collection consists of specimens picked up during a trip in the northern part of Costa Rica, the Limon District. The majority of them are from the hot, humid, lowland zone, but a few are from the more temperate Alpine zone. The dried specimens are accompanied by detailed field notes and unusually good photographs made by Mr. Stork from the fresh material.

The writer wishes to express her indebtedness to Dr. V. C. Dunlap, Dr. W. A. Murrill, Dr. F. J. Seaver, and Dr. E. A. Burt for their kind assistance in determining material.

Chlorophyllum Molybdites Mass.

The entire plant is white, being large and conspicuous in grassy places and having the general appearance of an Amanita but without a volva. The upper surface of the pileus is fibrillosely scaly, the scales brownish and adhering in a disc. The pileus is 12 cm. in diameter. The spores are of a characteristic flax-seed like form with one large guttulum and are apiculate at the point of attachment, 7–8 x 10–12 μ, decidedly green in color.

The natives of Costa Rica told Dr. Stork that it was good to eat but not as good as "the good mushroom that grows on trees."

La Junta, Costa Rica, 1920. *No. 528.*

Lentodiellum concavum (Berk.) Murrill

Plants entirely white, tough, growing in clumps or closely cespitose on dead fallen logs in clearing. Conspicuous, all united at the base. Pileus deeply infundibuliform, glabrous, reaching 7 cm. in diameter.

Santo Domingo and throughout tropical America.

This material was collected at Guacimo, Costa Rica. *No. 557.*

LENTINUS SUBSCYPHOIDES Murrill

Plant gregarious on dead logs. Pileus funnel-shaped, thin, 1–2 cm. in diameter, glabrous, smooth, dark brown in center becoming mouse colored toward the margin.

Jamaica, Martinique, Porto Rico, and British Honduras.

Collected by Stork near La Junta, Costa Rica, July 17, 1920. *No. 525.*

LENTINUS STRIGOSUS (Schw.) Fries

Plant tough, leathery, almost funnel-shaped, 4 cm. high, upper surface of pileus yellowish brown, darker when young, with tufts of dark brown fibrils close together.

Cosmopolitan.

La America Farm, Costa Rica, *No. 569.* Very common in Costa Rica on dead wood.

LENTINUS CRINITUS (L.) Fries

Plant tough, cartilaginous, depressed to infundibuliform, entire plant yellowish-brown, lacking entirely the reddish tinge of *L. strigosus* but otherwise very much like it. Surface of pileus densely covered with stiff, squamose, dark, fuscous hairs.

Throughout the tropics and in certain states bordering on the Gulf of Mexico.

From decaying sticks beneath the surface of the soil, La America Farm. *No. 523.*

HEXAGONA FLORIDANA Murrill

Plant growing in great profusion on a large capulcine tree and much infected with a small fly. Has at first a gelatinous appearance but is of firm consistency. Pileus flabelliform, applanate. Surface white, glabrous, somewhat hygrophanous.

Previously known only from type locality, Miami, Florida.

Collected in 1920 near La Junta, Costa Rica. *No. 567.*

HEXAGONA PURPURASCENS (Berk. & Curt.) Murrill

Pileus spathulate, surface wine-colored, glabrous.

Known only from Cuba.

Collected near La Junta, Costa Rica. *No. 538.*

POLYPORUS DIABOLICUS Berk.

Pileus circular, slightly umbilicate, surface brownish-black, slightly radiate-striate, glabrous.

Mexico and Central America as well as South America.

One half mile from La Junta, Cost Rica, on the bank of the Reventazon. *No. 566.*

POGONOMYCES HYDNOIDES (Schw.) Murrill

Pileus dimidiate, sessile, often conchate. Surface bay to nearly black, covered with very long, rather distant, black, branched, fibrillose hairs.

Common throughout the tropics.

On dead logs in the forest at La Junta, Costa Rica. *No. 558.*

CORIOLUS PROLIFICANS (Fries) Murrill

Pileus very variable, mostly sessile, dimidiate to flabelliform. Surface tomentose, pallid to yellowish, slightly zoned.

Common on dead wood throughout the tropics.

Stork collected this on fallen trees on Irazu Volcano. *No. 556.*

CORIOLOPSIS OCCIDENTALIS (Klotzsch) Murrill

Pileus leathery to corky, dimidiate, applanate. Surface concentrically zoned, tomentose, grayish-ochraceous to grayish-isabelline.

Common on dead wood in tropics.

Very common on dead logs, near La Junta, Costa Rica. *No. 531.*

RIGIDOPORUS SURINAMENSIS (Miq.) Murrill

Plant very variable, dimidiate or reniform, nearly conchate, applanate or with very short, lateral, stipe-like attachment. Surface rugose, pruinose to glabrous, multi-concentrically zonate, isabelline to latericeous.

Commonly found on water soaked hardwood trees throughout the tropics.

On decayed wood near La Junta, Costa Rica. *No. 560–571.*

PYCNOPORUS SANGUINEUS (L.) Murrill

Common on dead wood throughout the tropics.

Collected near La Junta, Costa Rica. *No. 545.*

ELFVINGIA TORNATA (Pers.) Murrill

Surface brown to almost black, sulcate, horny-encrusted, with suggestion of blackish bands.

Common in the tropics on decayed wood.

Stork found it on dead roots near Livingston, Costa Rica. *No. 564.*

GANODERMA SUBFORNICATUM Murrill

Surface glabrous, rugose, concentrically sulcate, laccate, subshining.

Occasional in British Honduras.

Near the Reventazon river, one half mile from La Junta, Costa Rica. *No. 563.*

GANODERMA SUBINCRUSTATUM Murrill

Surface glabrous, sulcate, zonate, bay to dark brown.

British Honduras and in Jamaica.

Collected by Stork from dead roots, La Junta, Costa Rica, August 20, 1920. *Nos. 526, 559.*

DAEDALEA AMANITOIDES Beauv.

Common throughout tropics.

From dead wood, near La Junta, Costa Rica. *Nos. 530, 570.*

HYDNUM DISCOLOR Fries

Plant large, sponge-like, base broad, spongy, sterile. Top flattened, covered with spines, which are usually round or occasionally flattened, rarely fused. Closely crowded spines about 15 cm. to one half mm. in diameter and pointed at end. Hair-like hyphae covering surface of spines, especially at tips. Spores globose, thick walled, average 4 μ. Entire plant white, becoming yellow with age. Weight 1 pound or more.

On half dead trunks in Jamaica and Central America.

Collected on Irazu Volcano, elevation of 9000 feet. *No. 599.*

HYDNUM GUARANITICUM Speg.

Entire plant light tawny, hygrophanous, glabrous, with thin flesh and extremely thin margin, smaller spines extending to edge. Pileus 3–4 cm. diameter, coriaceous to membranaceous, 0.4–0.5

mm. thick. Spines crowded, concolorous, 0.5–0.7 mm. long, 0.1 mm. at greatest diameter, tapering to sharp point. Spores nearly spherical, hyaline, 4 μ.

In woods on trunks of trees throughout Paraguay.

From roots in a moist bank in a deep shaded ravine. Tuccurique, Costa Rica. *No. 568.*

HYMENOCHAETE DAMAECORNIS (Link) Lév.

Irregularly stipitate, glabrous, leathery. Pileus striate, erect, margin irregularly lobed. Upper surface velvety, golden-brown. Under surface smooth, darker brown with lighter margin. Spores round, 4 mm. in diameter.

Collected on the trail west of Squirres, Central America.

STEREUM DECOLORANS Berk. & Curt.

Entire plant white. Pileus cyathiform, faintly zoned, linearly striate. Stipe tomentose, hymenium glabrous, spores immature. Dr. Burt said: "This specimen is like *S. decolorans* in general aspect, color, and structure, but with the pileus more cut up than the West Indian gatherings. Have never seen anything like this exactly."

On trees in the woods of Cuba, Central America, Australia.

Collected on the old Spanish trail west of Squirres, from an old decaying stump.

STEREUM AUSTRALE Lloyd

Resupinate, round, 10–15 μ in diameter, slightly umbilicate. Fruiting surface golden yellow.

Argentina and Spanish America.

Collected on old Spanish trail west of Squirres.

AURICULARIA AURICULA (L.) Underw.

Concave, flabby but not sticky, dark, livid, almost black when dried.

Common in all parts of world.

Very common where Stork collected it on dead wood near Livingston, Costa Rica. *No. 547.*

GUEPINIA FISSA Berk.

Caespitose. Pileus fissured, narrowly spathulate, lobes becoming linearly striate at maturity. Hymenium pallid and subshining.

Stipe elongate, laterally compressed, velvety at base.

All through the tropical world.

Stork collected it at La America Farm. *No. 521.*

DALDINIA CONCENTRICA (Bolt.) Ces. & DeNot.

This plant is so common that it is hardly necessary to describe it. It is common on *Fraxinus, Alnus, Betula, Juglans, Acer, Corylus, Salix, Ulmus, Fagus,* etc.

In all Europe, Siberia, North and South America, India, Ceylon, Borneo, Tasmania, New Zealand, and Java.

Stork collected it near Sizuirres, Costa Rica, on decaying cross ties. *No. 561.*

DALDINIA sp.

This is different from *D. concentrica.* It is effused and forms a hard knobby mass, the surface of which is grayish black. The ostiola of the perithecia are visible to the unaided eye. In a cross section the concentric lines evident in *D. concentrica* are not visible. This specimen agrees perfectly with an unnamed specimen collected by Dr. W. A. Murrill in Mexico.

Collected at the Laguna near Irazu Volcano. *No. 548.*

XYLARIA POLYMORPHA Pers.

Plants black to dark bay, variable, caespitose or rarely solitary.

Very common and cosmopolitan.

Collected near La Junta, Costa Rica, where it was common on decaying logs. *No. 540.*

XYLARIA POCULIFORMIS Mont.

Solitary, obovate to poculiform, globose. Black to grayish-black, dull, with very short thick stipe. Perithecia few, scattered. ostiola concealed.

Mexico.

Near La Junta, on a large decaying log. *No. 541.*

COOKEINA SULCIPES (Berk.) O. Kuntze

Plants stipitate, cup-shaped, 1–2 cm. in diameter by 1 cm. deep. Exterior of cup marked at the margin by several concentric rings and with a fringe of very short subconical hairs which are more

1. Chlorophyllum Molybdites
2. Lentodiellum concavum

1a. Cookeina sulcipes
1b. Cookeina Tricholoma (hairy specimen)
2. Hymenochaete damaecornis

numerous at the margin. Plant flesh colored to nearly scarlet, paler outside than within. Stipe up to 3 cm. by 2 mm. Spores biguttulate, 12–15 x 25–30 μ.

West Indies, Mexico south to South America and Australia.

On dead sticks in deep forest at La Junta, Costa Rica. *No. 532.*

NECTRIA TUCUMANENSIS Speg.

Perithecia 1/3 mm. in diameter, cup-shaped to globose, crowded together in groups (some with as many as twenty), erumpent. Outer wall whitish, scaly fringe about deep flesh-colored center, spores very large reaching 12 x 40 μ, ellipsoid or slightly curved.

Previously collected only in Argentina.

Collected by Stork near Cairo, Costa Rica, on bark of unknown tree. *No. 539.*

EXPLANATION OF PLATES

PLATE 11

Fig. 1. *Chlorophyllum Molybdites* Mass.
Fig. 2. *Lentodiellum concavum* (Berk.) Murrill.

PLATE 12

Fig. 1. *Cookeina sulcipes* (Berk.) O. Kuntze. The immature hairy specimen is *Cookeina Tricholoma.*
Fig. 2. *Hymenochaete damaecornis* (Link) Lév.

FUNGI FROM CENTRAL MANITOBA

G. R. Bisby

" Norway House " is the name applied specifically to a post of the Hudson's Bay Co., and generally to an area on or near 54° north latitude and about 97° 50′ west of Greenwich. This region is along the Nelson River just north of Lake Winnipeg, and is some 350 miles north of the International Boundary, and about 300 miles from Hudson's Bay. It is near the geographical center of Manitoba, about the center of Canada in an east and west direction, and is approximately half way between a parallel passing through Pittsburgh and Lincoln, and the Arctic Circle. Norway House lies just within the geologically ancient Laurentian Plateau, and the Pre-cambrian rock is either exposed or lightly covered with soil. At first glance the plants and the rock formation resemble those found near the Lake of the Woods and north of Lake Superior. The trees are, however, somewhat smaller than they are three hundred miles southeast, and various species of plants found near the Lake of the Woods are missing from the Norway House region. Black spruce, jack pine, larch, poplars, birches, willows, and *Prunus* spp. are the common trees. Lowe[1] has listed the higher plants of an area a few miles from Norway House.

Norway House is within an enormous area of central Canada in which few surveys for fungi have been made. The fungi of southern Canada and the northern United States are moderately well known, and the fungi of the Arctic regions, including Alaska, Greenland, and the northern coast of Canada, have also received considerable attention.[2]

The nearest agricultural area is the Swan River Valley some 200 miles from Norway House, and the latter region is not much affected by civilization, although some potatoes, vegetables, sunflow-

[1] Lowe, C. W., The Flora of Warren's Landing, Lake Winnipeg, Man., Canadian Field-Nat. 34: 26–30, 1920.

[2] See Dearness, John, Report of the Canadian Arctic Expedition 1913–1918, Vol. IV, part C, pp. 1c–24c, 1923, for list of fungi and for references.

ers, timothy, and oats are grown, and these plants yielded certain of the fungi reported here.

The writer submitted various specimens to specialists, both in order to obtain accurate determinations, and in order to place specimens in herbaria where they would be useful as indicating the range of fungi. The names of those to whom fungi were sent are indicated below; to all of them the writer is grateful, and also to Professor V. W. Jackson for certain host determinations, and to Dr. A. H. R. Buller for examining certain fungi and for other help.

Norway House, with the nearby Rossville Mission Indian School, and the new Playgreen Inn at which to stay, is a splendid spot to spend a summer holiday; especially for one interested in the fungi. The 118 species here reported were all collected in the six days from Aug. 11 to 16, 1923. The range of several species of fungi is extended considerably northward.

It is still a common practice to designate simply "Canada" in giving distribution of fungi. Since Canada is about the size of the United States and Mexico combined, and extends from a peach belt at 42° latitude nearly to the North Pole, and from the 57th to the 141st meridian, it is evident that the name of the province or other destination should be given.

MYXOMYCETES

The slime molds were not abundant. The two marked "E" were determined by Dr. W. T. Elliott, Tanworth-in-Arden, England.

Craterium leucocephalum (Pers.) Dittm., *1630* E.
Didymium squamulosum (A. and S.) Fr., *1631* E.
Enteridium Rozeanum (Rost.) Wing, *1632*.

BACTERIA

The following bacterial diseases of plants were found:

Actinomyces scabies (Thaxt.) Güssow, common on potatoes, *1437*.
Bacillus atrosepticus van Hall. An occasional potato plant was found affected.
Pseudomonas Phaseoli, E. F. Sm., common on beans, *1448*.

PHYCOMYCETES

Rhizopus nigricans Ehr. Found on leaf mold. This was the only Phycomycete encountered. Dearness (l. c.) comments on the rarity of Phycomycetes in more arctic regions.

ASCOMYCETES

Numbers followed by "S" are identifications made by the courtesy of Dr. F. J. Seaver, New York Botanical Gardens.

Chlorosplenium aeruginosum (Oed.) De Not. on old wood, *1439.*

Claviceps purpurea (Fr.) Tul. on *Poa pratense, 1401;* on *Elymus innovatus, 1412;* on *Agropyron* sp. *1413.*

Daldinia vernicosa (Schw.) Ces. and De Not. on old wood, *1438.*

Diatrype spp. *1411* S, *1413* S.

Eleutheromyces subulatus (Tode) Fuckel, on a mushroom, *1480* S.

Erysiphe graminis D. C. on *Phleum pratense, 1427.* Perhaps it was too early for powdery mildews; only two were found.

E. polygoni D. C. on *Polygonum aviculare, 1443.*

Helotium citrinum (Hedw.) Fr. on wood, *1435.*

Hypoxylon fuscum (Pers.) Fr. *1415* S.

H. multiforme Fr. *1410* S, *1412* S.

Hysterium sp. on coniferous wood, *1405.* An interesting species with spores 4–6 by 34–43 μ. Not yet definitely determined.

Lophium mytilinellum Fr. I am placing as this species No. *1603* with hysterothecia 0.2–0.4 mm. long, and spores 1.5–2 by 90–120 μ. It was found on the bark of a coniferous tree.

Lophodermium pinastri (Schr.) Chev. on leaves of *Pinus Banksiana, 1404.*

Nectria cinnabarina (Tode) Fr. (*Tubercularia vulgaris* stage) *1414* S.

Peziza vesiculosa Bull. *1419.*

Rhytisma salicinum (Pers.) Fr. on willow leaves, *1411.*

Spathularia clavata (Schaeff.) Sacc. on old wood in mossy ground, *1408.*

FUNGI IMPERFECTI

Leaf spots were common. Numbers marked "D" were examined by Dr. J. J. Davis of Wisconsin.

Alternaria Solani (E. & M.) J. & G. on potatoes, *1418*. No spores were found but the spots were typical of early blight.

Cercospora antipus Ell. & Hol. on *Lonicera glaucescens, 1483*.

C. zebrina Pass. on *Trifolium repens, 1446*.

Cladosporium (probably *C. graminum* Corda) on *Poa pratense, 1402;* on oats, *1429*.

C. subsessile Ell. & Barth. on *Populus tremuloides, 1623*.

Cylindrosporium hiemale Higgins on *Prunus pennsylvanicus, 1444*.

C. lutescens Higgins on *Padus virginiana, 1606*.

Fusicladium radiosum (Lib.) Lindau on *Populus* leaves, *1434* D.

Phyllosticta Caricis (Fuckel) Sacc. on old leaves of *Carex vesicaria, 1628*.

Polythrincium trifolii Kze. on *Trifolium repens, 1447*.

Ramularia punctiformis (Schl.) v. Hoeh. on *Epilobium angustifolium, 1485*. The spores were found to be 18–26 by 3–4 μ, which is somewhat large for this species.

R. Taraxaci Karst. on *Leontodon Taraxacum, 1400*.

R. Tulasnei Sacc. common on leaves of *Fragaria canadensis, 1430*.

Rhizoctonia Solani Kuehn, common on potato stems and tubers, *1417*. This fungus is evidently common in this region; the *Corticium* stage was found twice on old wood.

Septoria alnifolia E. & E. on *Alnus incana, 1481*. Spores rather long, being 54–70 x 3 μ, but probably this species.

S. caricis Passer. on *Carex vesicaria, 1626*. The spores are 35–40 x 2.5 μ and fit this species, but I am not sure it occurs in North America.

S. Ribis Desm. common on *Ribes* spp. *1433*.

S. salicina Pk. (probably) on *Salix* spp. *1431* D.

Stagonospora sp. on *Carex vesicaria, 1626*.

BASIDIOMYCETES

Ustilaginales. Only the following three smuts were found at Norway House, and one of these was introduced. The smuts are rare in the arctic regions further North.

Cintractia Caricis (Pers.) Magn. on *Carex aquatilis*, common, *1406*.

Ustilago levis (K. & S.) Magn. on *Avena sativa, 1445*.

U. Lorentziana Thuem. on *Hordeum jubatum.* Very common, *1428.*

Uredinales. The rusts are apparently rare in arctic regions, but as far south as Norway House they are evidently quite numerous.

Coleosporium Solidaginis (Schw.) Thuem. Common on *Solidago multiradiata, 1415.*

Melampsora Bigelowii Thuem. on *Salix* spp. common, *1432.*

Melampsoropsis ledicola (Peck) Arth. I common on *Picea mariana, 1604;* II on *Ledum groenlandicum, 1403.* This rust determined by W. P. Fraser.

Phragmidium Rosae-acicularis Liro, II, III on *Rosa acicularis, 1407.*

Puccinia epiphylla (L.) Wettst. II common on *Poa pratensis, 1416.*

P. gigantea P. Karst. III on *Chamaenerion angustifolium, 1605,* det. H. S. Jackson. This extends the range considerably eastward.

P. graminis Pers. Especial attention was paid to the occurrence of this rust, because of the data it would give on the spread of the urediniospores by the wind. At Beren's River, half way up Lake Winnipeg, this rust was already abundant on Aug. 9 on a small patch of oats and on *Hordeum jubatum.* At Grand Rapids on Aug. 10 no *P. graminis* could be found. At Norway House rust was common but not serious on timothy, *1424;* this form evidently overwinters there in the uredinial stage. Hundreds of *Hordeum jubatum* plants were examined before a couple of pustules of primary infection were finally found at Rossville Mission on Aug. 14, No. *1425.* Two or three pustules were found at the same date and place on a plot of oats, *1423.* The *Avenae* and the *Tritici* or *secalis* forms had apparently just reached the Norway House region in time for early infections to appear by the middle of August. The early and continuous protection of the uredinial stage in autumn and winter by snow, and the sudden spring, might appear to favor overwintering of this stage; but evidently only the timothy form lives over winter there. On the return trip, rust was found on Aug. 17 on *Hordeum jubatum* at Grand Rapids, *1397,* and in increasing quantities as we went south.

P. Grossulariae (Schum.) Lagerh. I on *Ribes* sp. *1450.*

P. Helianthi-mollis (Schw.) Jackson II, III on *Helianthus annuus* (cult.), *1426.*

P. lysimachiata (Schw.) Kern I on *Naumburgia thyrsiflora, 1409.*

P. urticata (Link) Kern on *Carex* sp. *1629.*

Pucciniastrum arcticum (Lag.) Tranz. on *Rubus triflorus, 1410.*

P. pustulatum (Pers.) Diet. on *Chamaenerion angustifolium, 1449.* Determination verified by W. P. Fraser.

Tremellales. All fungi marked "Ll" here and elsewhere were determined by Mr. C. G. Lloyd.

Exidia glandulosa (Bull.) Fr. *1442.*

Tremella lutescens Fr. *1622* Ll.

T. mesenterica Fr. *1621* Ll.

AGARICALES

THELEPHORACEAE and HYPOCHNACEAE (on old wood unless otherwise noted). All numbers marked "B" were identified by Dr. E. A. Burt.

Corticum arachnoideum Berk. *1465* B and *1466* B.

C. laetum Karst. *1460* B.

C. livido-caeruleum Karst. *1462* B.

C. vagum B. and C. *1475* B, *1477* B.

Hypochnus cervinus Burt. *1457* B.

H. fumosus Fr. *1459* B.

Peniophora glebulosa Bres. *1458* B, *1476* B.

P. subalutacea Karst. *1464* B.

Stereum fasciatum Schw., *1451* B.

S. rufum Fr. common on fallen poplar branches, *1436* B.

S. ochraceoflavum Schw., det. by C. H. Kauffman.

S. rugosiusculum B. & C. *1452* B. According to F. T. Brooks, the same as *S. purpureum.*

Thelephora caryophyllea (Schaeff.) Fr. *1454* B.

T. intybacea (Pers.) Fr. *1455* B.

T. terrestris (Ehrh.) Fr. *1453* B, *1470* B.

Clavariaceae: Clavaria ligula Schaeff. *1468* B.

C. pulchra Pk. on ground, *1469* B.

C. stricta Pers. on decaying wood, *1474* B.

Hydnaceae: Hydnum caeruleum Fl. Dan. *1471* B.
H. connatum Schultz (*H. cyathiforme* Schaeff.) *1473* B.
H. mirabile Fr. (probably) *1472* B.
H. repandum Fr. Found but not preserved.
Odontia spp. *1494* V, *1463* B.

POLYPORACEAE. Dr. L. O. Overholts reported on those fungi marked "V."

Daedalea unicolor Bull. *1486* V, *1499* V.
Favolus canadensis Klotz, *1420* V.
Fomes fomentarius (L.) Gill. *1491* V.
Lenzites betulina Fr. *1495* V.
L. saepiaria Fr. *1496* V, *1497* V.
Merulius niveus Fr. *1461* B.
M. pilosus Burt. *1456* B, *1467* B.
Polyporus betulinus Bull. *1421* V, *1422.*
P. biformis Kl. *1490* V.
P. caesius Fr. *1492* V.
P. pargamenus Fr. *1489* V.
P. pubescens Schum. (or possibly var. *Grayii* according to Dr. Overholts), *1487* V.
P. tulipiferus (Schw.) Overh. (probably) *1498* V.
Trametes carnea Nees, *1600* V.
T. hispida (Bagl.) Fr. *1601* V.

BOLETACEAE. *Boletus scaber* Fr. occurred commonly, and also half a dozen other species which I could not identify with certainty.

AGARICACEAE. Gill fungi were abundant at Norway House during my stay there, since I chanced to strike a period of fine weather following rains. I had neither time nor facilities, however, to handle them, and could only dry a few of them, and Dr. Kauffman kindly looked these over; he reported those marked here with "K" as being forms of which he felt sure of the identification. Those not marked were identified by the writer in the field.

Cantharellus aurantiacus Fr. K.
C. umbonatus Fr. K.
Clitocybe laccata Quél. K.
Coprinus micaceus Fr.

Cortinarius calochrous Fr. K.
Crepidotus herbarum Pk. K.
Flammula sapinea Fr. K.
Inocybe minima Pk. K.
Lactarius parvus Pk. K.
L. torminosus Fr. K.
Naucoria pediades Fr.
Panaeolus solidipes Pk.
Russula chamaeolentinus Fr. K.
R. emetica Fr.
R. graminicolor Quél. K.

LYCOPERDALES

Lycoperdon cepaeforme Bull. (?) *1609* Ll.
L. spadiceum Pers. (?) *1607* Ll.

MANITOBA AGRICULTURAL COLLEGE,
WINNIPEG, CANADA.

NOTES AND BRIEF ARTICLES

[Unsigned notes are by the editor]

The caption under plate 7 of the March issue of MYCOLOGIA should be corrected to read, " Phyllachora graminis on Agropyron repens."

Dr. Arthur S. Rhoads, pathologist of the Missouri State Fruit Experiment Station, has accepted the position of Assistant Plant Pathologist of the Florida Agricultural Experiment Station.

Snapdragon rust, according to Butler, of the New Hampshire Agricultural Experiment Station, can not be controlled in the field either with sulphur or with the copper fungicides. This conclusion is based on field experiments.

A new enemy of the cocoa, *Trachysphaera fructigena,* causing the disease known as " mealy pod," has been described by R. H. Bunting in the *Gold Coast Journal.* For the control of this downy mildew, it is necessary to bury all diseased pods and all husks from which the seeds have been removed, thus preventing the distribution of the spores.

Dr. Sanford M. Zeller, of the Oregon Agricultural College, visited the Garden during the Christmas holidays to examine specimens of underground puffballs (Hymenogasters). Very few of these fungi occur in the eastern United States, but they are quite frequent on the Pacific coast, especially in California.

An excellent set of seventy sample specimens of species of *Clavaria,* the principal genus of the coral-fungi, has recently been sent to the Garden herbarium by Professor W. C. Coker, of the University of North Carolina, who is the author of the latest book on this

interesting family of fungi. These specimens will be very valuable for determining new material in this group.

Dr. C. F. Millspaugh, who died last September, was much interested in fungi although his chief work was with flowering plants. He was born in Ithaca, N. Y., about seventy years ago; practised medicine several years at Binghamton; and became curator of the department of botany in the Field Museum of Chicago in 1894, which position he held until his death. Much of his time was devoted to botanical exploration in tropical America.

The Higher Fungi of the Hawaiian Islands, by Dr. E. A. Burt, appeared in the *Annals of the Missouri Botanical Garden* for April, 1923. The paper treats of collections made by F. L. Stevens, C. N. Forbes, and others, comprising 61 species, about half of which are polypores. The author concludes that very few North American species of the higher fungi occur in Hawaii. *Crepidotus rhizomorphus, Fomes fasciculatus, Corticium granulare,* and *Epithele hydnoides* are described by Dr. Burt as new.

A systematic presentation of new genera of fungi published since volume 22 of Saccardo's "Sylloge" appeared was printed in the *Transactions of the American Microscopical Society* for January, 1923. The authors, O. A. Plunkett, P. A. Young, and Ruth W. Ryan, of the University of Illinois, catalogued about 7,000 new species of fungi described since 1910 in the preparation of this valuable paper. The new generic names are tabulated in the main according to the Engler and Prantl system.

Diseases of ornamental and forest trees are discussed by C. J. Humphrey in the annual report of the Wisconsin State Horticultural Society for 1922. Important tree fungi like *Rhytisma acerinum, Sphaeropsis ulmicola,* and *Armillaria mellea* are given considerable attention. Shellac is recommended for small wounds and for larger ones a 50:50 mixture of coal-tar creosote and as-

phaltum, except in case of delicate trees like the peach, magnolia, and tulip, where the asphaltum should be increased to 75 per cent.

A brief sketch of the life and work of Dr. Elias J. Durand with a photograph and a list of his publications, prepared by Prof. R. B. Harvey, appeared in *Phytopathology* for September, 1923. He was born at Canandaigua, New York; was educated at Cornell University and taught botany there from 1893 to 1910; and was called to the University of Missouri and then to the University of Minnesota, where he died in the fall of 1922. Dr. Durand was a born teacher and much loved by his pupils. His mycological work was mainly with the discomycetes. His herbarium, containing over 12,000 specimens of this group of fungi, is now at Cornell.

The season of 1923 was notably a poor one for fungi about New York City owing to the unprecedented drought, which prevented the mycelium from developing. The late rains, which usually bring out a large crop of mushrooms, were practically without effect this year. East of Conservatory Range 1, where there are usually quantities of *Boletus luteus* under the pines, I counted only half a dozen fruit-bodies. Several scattered specimens of *Agaricus campester* were picked up on the lawns in October, but the crop was soon exhausted. *Hypholoma perplexum* and *Armillaria mellea* were also scarce early in November and I noticed only a single specimen of the oyster mushroom. A cluster of *Pholiota squarrosa* was found on a white willow trunk by the Bronx River in North Meadows on October 12, which recalled a similar specimen collected on willow south of Upsala, Sweden, several years ago. *Collybia velutipes* was frequent on elm logs and stumps, being greedily eaten by gray squirrels. *Pleurotus ulmarius* was common on elms all about the city toward the latter part of November.

MARASMIUS ON WHEAT

Many of the species of *Marasmius* habitually grow on fallen leaves and a variety of other dead plant parts. We had never, however, seen any of the Agaricales growing on wheat until the past summer when an interesting and remarkable instance was observed.

While examining a field of Red Wave wheat near Worden for the usual parasitic fungi a single dead culm was found with a number of fruiting stalks of a small mushroom, which had grown directly out of the basal node of the wheat stem.

The fungus is evidently a member of the genus *Marasmius* and appears to us to be closely allied to the species *M. scorodonius* Fr.

While these fungi are not characteristically parasitic, we think it probable in this case that, because of the size of the plant, the date of collection, the rotted roots and the discoloration in the basal node only, a parasitic condition did exist. L. R. TEHON

KASHMIR FUNGI

A collection of fungi recently presented to the Garden by Mr. R. R. Stewart, who collected them in late summer at Sonamarg, Kashmir, India, at an elevation of from nine to twelve thousand feet, proves very interesting because it contains such a large percentage of species found in New York. Hooker botanized extensively at Sikkim, India, fifteen hundred miles to the southeast, in a rainy region and his collections of fungi were quite different from those of Mr. Stewart. The Kashmir collection contains such familiar species as *Lentinus strigosus, Pleurotus ostreatus, Melanoleuca melaleuca, Pholiota squarrosa, Omphalia campanella, Strobilomyces strobilaceus, Lycoperdon giganteum, Auricularia auricula,* a form of *Thelephora palmata, Stereum hirsutum,* a giant form of *Calocera corniculata, Polyporus picipes* of European authors, *Pycnoporus cinnabarinus, Laetiporus sulphureus, Coltricia perennis, Bjerkandera adusta, Grifola umbellata* (a favorite edible species there), *Fomes ungulatus,* and *Elfvingiella fomentaria,* which occurs on birch as with us. A few species, however, have a very unfamiliar appearance and evidently do not belong to our flora. Among these I may mention a yellow *Poria* on birch, a very hirsute *Lentinus,* two or three species of *Mycena* and *Collybia,* and some boletes. *Gyrophragmium Delilei* Mont., represented in the collection by two specimens, is said to occur in southern France, northern Africa, and central Asia. It is very peculiar in appearance, suggesting a double-decked mushroom, the lower part expanding like a flower and bearing at its center a small cap supported on a stalk of its own. W. A. MURRILL

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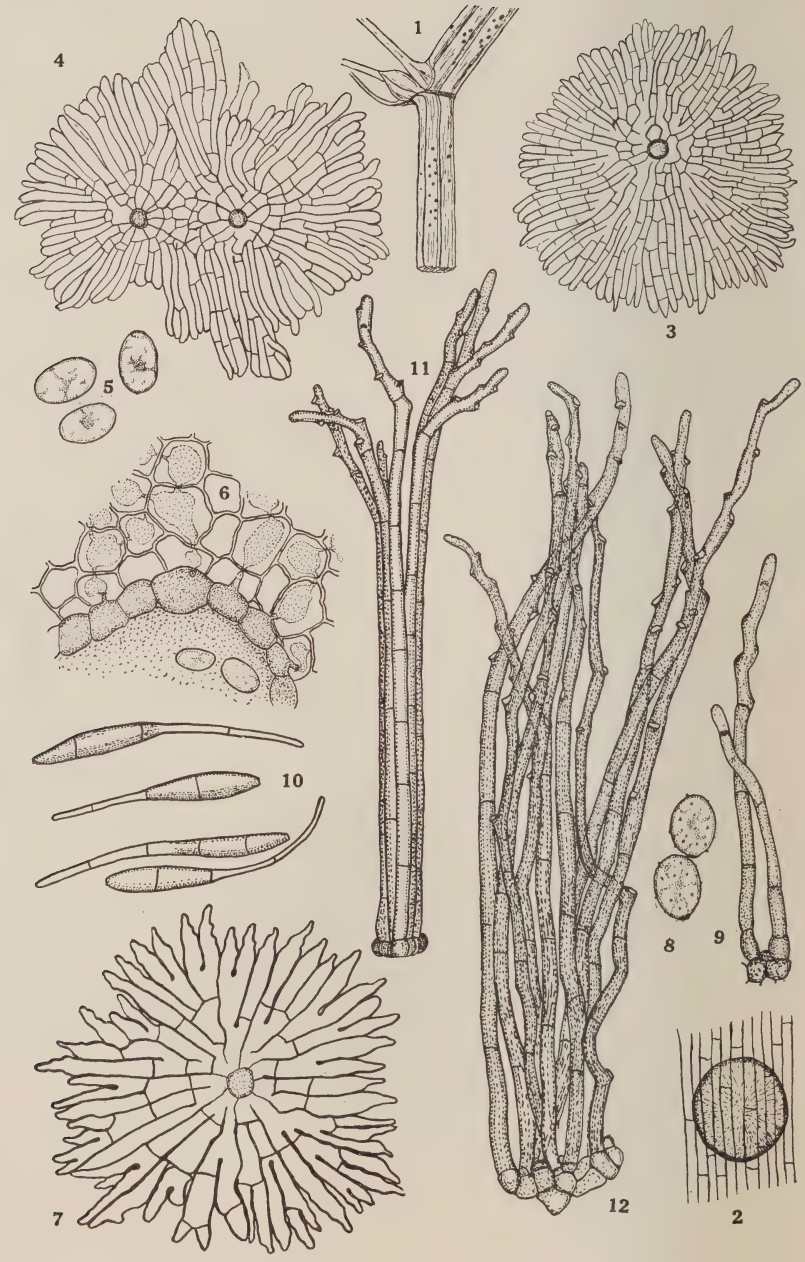

New Fungi from Illinois

MYCOLOGIA

VOL. XVI JULY, 1924 No. 4

NOTES ON THE PARASITIC FUNGI OF ILLINOIS

L. R. TEHON

(WITH PLATE 13)

During the years 1881 and 1882 the State Natural History Survey began the study of the parasitic fungi of Illinois. The collections made in those years by A. B. Seymour and the resulting publications on the rusts of Illinois by T. J. Burrill and on powdery mildews by Burrill and F. S. Earle have so long been a part of the working material of the mycologist that they need no comment.

In 1921 the task was undertaken again by the Natural History Survey. The intention of this later program has been especially to ascertain what plant diseases occur in Illinois and what their distribution within the state is. Particular attention is being paid to the common diseases of crops, but there is being accumulated a considerable quantity of other material. As time allows this material is being studied, and it is planned to publish the results of the studies from time to time as things of interest or value accumulate.

The fungi included in this paper are new, or have not hitherto been reported from Illinois. They are, for the most part, collections made in southern Illinois during 1922 by P. A. Young.

Septoria atropurpurei n. sp.

Spots 2–10 mm. in diameter, irregularly circular, reddish-brown with a small paler center above, evident below as discolored brownish patches, often coalescent and involving much of the leaf. Pycnidia numerous, scattered but more frequent in the center of the

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spot, erumpent above but evident beneath, 200–250 μ in diameter. Spores filiform, commonly crescent-shaped but often flexuous, ends tapering but not acute, hyaline to smoky, chiefly 3-septate, 22–45 x 2 μ; most often 29–32 μ long.

On *Evonymus atropurpureus* Jacq.

Marion, Williamson County, Illinois, July 19, 1922. Acc. No. 2064 (type).

Six species of *Septoria* have been described on *Evonymus*. On *E. japonicus* there are three species from which ours is distinguishable by the size, shape and septation of the spores. It is separated from *S. evonymi* Rabenh. on *E. europaca* by its consistently larger spores. There is some similarity to *S. semi-circularis* Sacc. & *Scalia* in the spore curvature but this character is not sufficiently constant in our species which also possesses larger pycnidia and consistently larger spores. From *S. spiculispora* E. & E. it is distinguishable because of its larger pycnidia and longer, wider spores.

Leptothyrium brunnichiae n. sp.

Caulivorus. Spots slightly blanched, limited laterally by the angles of the stem but extending considerable distances longitudinally. Pycnidia numerous, black, subcuticular, 200–225 μ in diameter. Spores continuous, oval, hyaline, 3.5–4.5 x 1.5 μ.

On *Brunnichia cirrhoe* Gaertn.

Karnak, Pulaski County, Illinois, Aug. 8, 1922. Acc. No. 1120 (type).

The unusually small spores of this species distinguish it from *L. vulgare* (Fries) Sacc. Its mycelium is parasitic in the superficial cells of its host. Tissue invasion appears to extend longitudinally along the stem but not laterally to any extent. A thin hyalin mycelium follows the cell walls, sending thin filamentous haustoria into the cells. At intervals strands of mycelium come to the surface and by a process of cell proliferation form a thin, shield-shaped, parenchymatous pycnidium beneath the cuticle. The habit of the fungus is shown in figures 1 and 2.

Actinothyrium gloeosporioides n. sp.

Spots round, straw-colored to brownish, 2–5 mm. in diameter, with a definite, raised, brown border. Pycnidia epiphyllous, nu-

merous, scattered, superficial, radiate, opening by a definite pore, often confluent, 50–95 μ in diameter. Spores oval, hyaline, continuous, 6–7.5 x 11–12 μ. Superficial mycelium lacking; endophyllous mycelium invading and parasitizing the cells of the epidermis and deeper tissues.

On *Sassafras variifolium* (Salisb.) Kze.

Christopher, Franklin County, Illinois, July 20, 1922. Acc. No. 2972 (type). Johnson City, Williamson County, July 18, 1922. Acc. No. 3671.

The spot caused by this fungus is similar to the *Gloeosporium* spot so common on *Sassafras* in Illinois. It is evident, however, that this fungus is parasitic and causes the spots upon which it is found. The connection of the pycnidia with endophytic mycelium is shown in figure 6. The radiate character of the pycnidium is shown in figure 3 and the joining of pycnidia in figure 4. Spores are shown in figure 5.

Pirostoma nyssae n. sp.

Spots variously distributed upon the leaf, more frequent along the midrib and margins, large (5–20 mm.) with a black border enclosing a bleached halo, the halo surrounding an island of contracted, blackened leaf tissue on the upper side. Zonation not so apparent beneath. Pycnidia epiphyllous, distribution limited to the black center of the spot, 60–95 μ in diameter, superficial, radiate, opening by a roundish stoma, edge made irregular by the extending points of the hyphae composing the pycnidial covering. Spores olivaceous to brown, slightly verrucose, oval, 7 x 12 μ, appearing slightly stalked at the basal end. Mycelium abundant in the tissues of the host leaf which it parasitizes, kills and blackens.

On *Nyssa sylvatica* Marsh.

Tunnel Hill, Johnson County, Ill., July 25, 1922. Acc. No. 2940 (type).

This is not *Leptothyrium dryinum* Sacc. It differs in the nature of the pycnidium (fig. 7) which is radiate and has a round opening, and in the shape and color of the spores (fig. 8). We have placed it in *Pirostoma* in spite of the slight roughness of the spore case feeling that the conglobate character of *Discomycopsella*, which this species does not possess, was more distinctive than spore case characters.

Our specimen showed some perithecia of the same character as the pycnidia which contained immature asci. These asci were oblong-clavate, 30–35 x 15–17 μ, and appeared to contain hyaline, filiform spores.

Cercospora menispermi E. & H.

On *Menispermum canadense* L.

Francis, Saline County, Ill., July 13, 1922. Acc. No. 2299.

While apparently conspecific with Ellis and Harkness' species, this specimen is remarkable in having spores as long as 140 μ. The slenderness of the conidiophores and spores is remarkable being as a rule 3.5 μ. The spore color is variable, some spores being almost hyaline.

Cercospora personata (B. & C.) Ell.

On *Arachis hypogaea* L.

Chester, Randolph County, Ill., Aug. 22, 1922. Acc. No. 3155. This is the first report of this *Cercospora* in Illinois.

Cercospora chionea E. & K.

On *Cercis canadensis* L.

Makanda, Jackson County, Ill., August 19, 1922. Acc. No. 505. Thebes, Alexander County, August 17, 1922. Acc. No. 604.

These specimens differ from the original description of the species in having conidiophores as long as 75 μ and spores that vary from 1- to 8-septate. The spores also show more variation in length, measuring 30–65 μ.

Cercospora cruenta Sacc.

On *Vigna sinensis* Hassk.

Makanda, Jackson County, Ill., Aug. 19, 1922. Acc. No. 640.

This is the first report of the occurrence of this species in Illinois.

Cercospora echinocystis E. & M.

On *Echinocystis lobata* (Michx.) T. & G.

Gallatia, Saline County, Ill., July 13, 1922. Acc. No. 2325.

This is the first report of the occurrence of this species in Illinois.

Cercospora bliti Tharp.

On *Rubus* sp. Cultivated Blackberry.

Thebes, Alexander County, Ill., August 17, 1922. Acc. No. 526. Etherton, Jackson County, Ill., August 21, 1922. Acc. No. 1701.

This species was identified by comparison with specimens furnished us by Professor Tharp from Texas.

Cercospora plantaginella n. sp.

Spots small 0.5–1.5 mm. in diameter, white, with a dark somewhat raised border, round, limited. Conidiophores dark-olivaceous to brown, septate, 45–85 x 4.5 μ. Spores hyaline, 44–120 x 2.5–3 μ, 6–10-septate, straight, obclavate.

On *Plantago rugelii* Dcne.

Boaz, Massac County, Illinois, August 8, 1922. Acc. No. 1140 (type).

Cercospora plantigenis Sacc. recorded on *Plantago lanceolata* and on *P. major* has different spots and shorter, narrower conidiophores with much longer and wider spores.

Cercospora hemerocallis n. sp.

Spots circular, frequently confluent, brownish with a distinct, raised red margin, 0.5–4 mm. diam. Sporophores erect, short, 40–60 x 4 μ, fascicled, light-olivaceous, septate, tips distinctly lighter, basal cell often expanded and spherical. Spores hyaline, obsolete septate 3–5 times, acicular, straight or slightly curved, 75–110 x 3–4 μ.

On *Hemerocallis fulva* L.

Bloomfield, Johnson County, Ill., July 25, 1922. Acc. No. 2897 (type).

Cercospora psedericola n. sp.

Spots 1–3 mm. in diameter, extending through the leaf, black above and below when old. Sporophores hypophyllous, fascicled and spreading, olivaceous, septate, 45–85 x 4–4.5 μ. Spores olivaceous, obclavate, the upper portion distinctly larger than the remainder, 2–7-septate, 47–66 x 7–8 μ.

On *Psedera quinquefolia* (L.) Greene.

Buckner, Franklin County, July 20, 1922. Acc. No. 2987 (type).

Two species hitherto recorded on *Psedera* (*C. ampelopsidis* Pk. and *C. pustulata* Cke.) are said to be similar to each other, except for color and length of spores. They differ distinctly from our species in character of spots and in size of conidiophores and spores. The spore shape of our species is particularly distinctive, the upper 2 or 3 cells frequently being so enlarged and rounded as to appear to append the remaining more slender part of the spore. The characters of the conidiophores are shown in figure 9, and those of the spores in figure 10.

Cercospora cercidicola Ell. var. **coremioides** n. var.

On *Cercis canadensis* L.

Boaz, Massac County, Ill., August 8, 1922. Acc. No. 1129 (type of the variety).

This specimen shows spots that are characteristic and the spores fall well within the measurements of the species, although tending to be somewhat longer and to show one or two septa only. It is remarkable on account of the conidiophores which vary from 210 to 310 μ long, are rigid, upright, and closely adherent throughout the greater part of their length, loosening only at the tip where the spores are borne as shown in figure 11. The character of the conidiophores leads us to establish the variety.

Cercospora nepetae n. sp.

Spots subcircular, 0.5–3 mm. in diameter, grayish with a narrow brown margin. Fasciculae amphigenous, erect, more abundant toward the center of the spot, usually rising above the trichomes. Sporophores long, erect, lax, gregarious, dark olivaceous, septate, with a long sporogenous tip showing many scars, 110–225 (mostly 180) x 4–4.5 μ. Spores hyaline, variable, 40 x 3.5–4 μ and 1-septate to 118 x 3.5–4 μ and 3-septate, cylindrical, straight, ends blunt or rounded, rarely curved and cylindrical-obclavate.

On *Nepeta cataria* L.

Ullin, Pulaski County, Ill., August 11, 1922. Acc. No. 1419 (type).

The conidiophores of this species shown in figure 12 are particularly striking and distinctive.

Cercospora viminei n. sp.

Spots amphigenous, more apparent above, light brown, definitely limited, 4–8 mm. in diameter, usually separate, but occasionally confluent and then involving much of the leaf. Fasciculae abundant, even crowded, on both surfaces of the spot, erect. Sporophores light-olivaceous, numerous, upright, undulating, continuous or rarely 1–2-septate, arising from a black sub-epidermal stroma. apically denticulate, occasionally short-branched at the tip, 36–55 x 4.5 μ. Spores hyaline, extremely variable in shape, short, cylindrical and continuous to longer, obclavate and 5-septate, straight or somewhat curved, 36–65 x 4.5–5.5 μ.

On *Aster vimineus* Lam.

Waltonville, Jefferson County, Ill., June 23, 1922. Acc. No. 2600 (type).

A first view of this species, with its abundance of immature spores, led us to think it a *Ramularia*. Later examination, with a view to specific determination, revealed its identification with *Cercospora*. The collection is especially interesting because of the abundance of spores upon the numerous fasciculae which give a whitish appearance to the spot. There is a suggestion of *Ramularia virgaureae* Thuem. in the manner, though not in the degree, of spore variation.

Colletotrichum trillii n. sp.

Spots large, 5–20 mm. in diameter, often becoming confluent and involving the entire leaf, dead areas brown, definitely limited and sunken, areas recently invaded by the mycelium dark green and appearing water-soaked. Acervuli dark brown to black, circular in outline, amphigenous but chiefly epiphyllous, numerous. Setae abundant, chiefly visceral, brown, acute with bulbous base, 65–95 μ long. Spores hyaline to smoky-green, allantoid, nonseptate, 15–18 x 3.5 μ.

On *Trillium recurvatum* Beck.

Ryder, Jefferson County, Ill., June 23, 1922. Acc. No. 2350 (type).

Type specimens have been designated by the accession numbers they occupy in the Survey Herbarium. Whenever types are distributed to other herbaria the specimens will bear labels duplicating exactly those on the specimens in our herbarium. It is hoped

that this procedure will eliminate any confusion which might arise from the use of numbers assigned by collectors.

STATE NATURAL HISTORY SURVEY,
URBANA, ILLINOIS.

EXPLANATION OF PLATE 13

Fig. 1, 2. *Leptothyrium brunnichiae:* 1, habit sketch; 2, pycnidium.
Fig. 3–6. *Actinothyrium gloeosporioides:* 3, pycnidium; 4, confluent pycnidia; 5, spores; 6, connection of pycnidium and endophytic mycelium.
Fig. 7, 8. *Pirostoma nyssae:* 7, pycnidium; 8, spores.
Fig. 9, 10. *Cercospora psedericola:* 9, sporophores; 10, conidia.
Fig. 11. *Cercospora cercidicola* var. *coremioides,* sporophores.
Fig. 12. *Cercospora nepetae,* sporophores.

NEW AND NOTEWORTHY FUNGI.[1]—III[2]

John Dearness

BASIDIOMYCETES

Following a dry summer the warm and showery autumn of 1923 was more than usually favorable for the development of fleshy fungi in southwestern Ontario. Examples of a number of species that I collected or received reached or exceeded the maximum size ascribed to them in the literature consulted. A few of these are noteworthy either on account of such excess or as a record of distribution.

Lepiota procera Fries

Delaware, Ont., Oct. 1, 1923.

Pileus not circular; 20.9 cm. and 17.6 cm. in transverse diameters.

Pleurotus sapidus Kalchb.

At Pond Mills, Ont. A prone elm trunk overlying a creek and its swampy margin bore a number of imbrications of this mushroom. The largest pileus was laid on white paper and threw down a beautiful lilac spore-print 34.7 by 20.4 cm. Portions of this collection, fried in the manner of "crumbed oysters," were served for three or four successive days and much enjoyed by the partakers.

Lepista graveolens (Peck) Murrill

In Rondeau Park, Ont., Oct. 1923.

"Growing in circles and troops, fifty or more plants in each colony. The largest individuals between 10 and 12 cm. broad."—Dr. C. C. Bell.

Agaricus placomyces Peck

Near London, Ont., in woods, Sept. 4, 1923.

[1] Acknowledgments for opportunity to examine type or co-typic material and for citations of literature are due Dr. H. D. House and Dr. F. J. Seaver.

[2] I, Mycologia **8**: 98–107. 1916. II, Mycologia **9**: 345–364. 1917.

One fresh plant measured 15.5 cm. across the top; the lamellae were 12 mm. wide and the annulus extended 29 mm. from the stem. A partially decayed plant measured about 17 cm. in diameter. On Oct. 5, Dr. T. Bowman brought in fresh specimens between 11 and 12.5 cm. in diameter. This species is not a favorite among mycophagists but this last collection made a savory and acceptable dish.

Dr. C. C. Bell, who has studied the fleshy fungi of Rondeau Park, Lake Erie, finds a white form of *A. placomyces* rather common which is nearly smooth even to the center of the pileus.

A. Rodmani Peck, nearly hemispheric, 9.75 cm., and *A. haemorrhodarius* Fries, over 9 cm., both growing within the city (London), are worth noting.

BOLETUS HEMICHRYSUS Berk. & Curtis

In cleft of a living trunk of *Quercus rubra* L., Rondeau Park, Ont., Sept. 30, 1923; Dr. C. C. Bell.

A fine large golden yellow specimen. "Flesh turning bluish when cut." To plants of this species with this character Dr. Peck gave the variety name *mutabilis*. He recorded that it inhabited stumps of *Pinus Strobus* L.

CALVATIA BOVISTA (L.) McBride

The giant puff-ball is a fairly common species in southern Ontario. In the first week of October Dr. T. Bowman brought me half of a globose specimen whose circumference was 4 ft. 3 ½ inches. It was solid,—the growth evidently not completed. This was small, however, compared with the Herkimer Co., N. Y., specimen reported by the late Prof. C. E. Bessey in the American Naturalist, May, 1884, which was a flattish, somewhat irregular fruit whose shorter diameter as measured by Professor Call was 4 ft. 6 inches.

MYRIOSTOMA COLIFORME Dicks.

Essex Co., Ont., Oct. 4, 1922.

Specimens opened; date of maturity uncertain. The spread of the ectoperidium of the largest specimen was 16.4 cm. from tip to tip; the inner peridium, 5.4 cm. in diameter.

MYCENASTRUM CORIUM Desvaux

Gatineau Pt., Ottawa River, Ont., June 1919; W. S. Odell: *197.* Essex and Kent Counties, Ont.; Oct. 3–4, 1922. Specimens fresh, white and firm inside. D. *4391.*

PHYCOMYCETES

PERONOSPORA LOPHANTHI Farl., var. **Moldavicae** Dearn. & Barth. var. nov.

Conidiophores 100–225 μ long, 10–12 μ thick at base, once to thrice dichotomous, unequally forcipate—the longer fork usually about 15 μ, the shorter 9 μ. Conidia sometimes globose, oftener limoniiform, the latter 25–32 x 17–23 μ. The spores are larger and the conidiophores less complex than in the type. No oöspores were found.

On *Moldavica parviflora* (Nutt.) Britt. Ten Sleep Canyon, Wyo., Aug. 29, 1923. E. Bartholomew: *8339.*

DISCOMYCETES

Phacidium Gaultheriae sp. nov.

Scattered irregularly on whitened areas which surround the stems for one to several cm., black, shining, opening mostly by four triangular laciniae, .7–1 mm. in diameter. Asci clavate, rounded at top, 8-spored, 105–135 x 14–15 μ, paraphysate. Sporidia hyaline, elliptic, sub-acute or rounded at ends, uniseriate or biseriate at the widest part a short distance from the top of the ascus, 12–19 x 6–9 μ.

On dead stems of *Gaultheria shallon* Pursh. Langley, Wash., Apr., 1923. J. M. Grant: *5090.* Besides being caulicolous it is much larger than *P. Vaccinii* Fr.

Mollisia Angelicae sp. nov.

Apothecia dark-brown, superficial, mostly hypophyllous, occasionally epiphyllous, sessile, rugose-costate, urceolate, leucostomate, 125 μ wide, 100–110 μ high, excipulum short-celled. Asci oblong to fusoid, 8-spored, 36–40 x 9 μ; scantily paraphysate. Sporidia hyaline, 2-nucleate, oblong but usually somewhat narrower at one end, biseriate or obliquely uniseriate, 9–15 x 2.5–3 μ.

On dead parts of living leaves of *Angelica atropurpurea* L. London, Ont., Sept., 1923. Dearness: *5416.*

More than 100 leaves were collected bearing both this *Mollisia* and *Fusicladium depressum* (B. & Br.).

ASCOBOLUS CROUANI Boud. (not Cooke)

An *Ascobolus* was collected on stems of *Brassica oleracea gemmifera* by Roy Latham: *577,* at Orient, N. Y., which is hardly separable from Boudier's *A. Crouani.* The sporidia, 15–19 x 10–11 μ, hyaline at first become so dark-brown as to obscure the reticulations which are longitudinal and anastomosing, about 6 visible on each side. "These Brussels sprouts stems were plowed under in November and turned up in the following spring; the collections were made about the end of June, 1922."—R. L.

HYPODERMATACEAE

The known hypodermatous needle-fungi are well represented in America. Some of them are weakly parasitic while others are of much economic importance, *e.g., Lophodermium pinastri* on nursery stock and *Hypoderma deformans,* a witches' broom producer on forest growth. See Dr. J. R. Weir's account of the latter in the Journ. Agr. Research, Vol. VI, pp. 277–288.

Recently v. Hoehnel [3] has exhaustively revised the Phacidiales, breaking up the old genera and creating a number of new ones. The forms here considered fall into three of his six groups: the Leptopeltineen, subcuticular, *e.g., Lophodermium lineare* (Peck) (*Bifusella* and 12 other genera); the Dermopeltineen, intra-epidermal, *e.g., L. pinastri* Schraed. (*Lophodermellina* and 9 other genera); and Phacidiaceen, *e.g., Hypoderma sulcigena* Rostr. (*Lophodermella* and 11 other genera). The more familiar names as employed by Tubeuf,[4] Lagerberg [5] and Lind [6] are used in making the following tabulation based on the spore forms. Tubeuf founded the genus *Hypodermella* to receive the species with spores

[3] Berichte der Deutsch. Bot. Gesellsch. **35:** 416–422, 1917; Annales Mycologici **15:** 311, 318, 503.

[4] W. G. Smith's Tr. Tubeuf's Diseases of Plants, 1897, and Tubeuf's Studien uber die Schuttekrankheit der Kiefer, 1901.

[5] Medd. fran Statens Skogsforsoksanstalt; Stockholm, 1910. From this I am indebted to Dr. J. R. Weir for translated citations.

[6] Danish Fungi: Herbarium of Rostrup; Copenhagen, 1913.

Name	Host	Apothecium length	Ascus in μ	Sporidia in μ
Rhabdocline				
Pseudotsugae Syd.	*Pseudotsuga taxifolia*	Medium and variable	58–147 × 14–19	15– 20 × 6–8½
Hypoderma				
(*a*) *brachysporum* (Rostr.) Tub. = *strobicola* Tub. = *Desmazierii* Duby	*Pinus Strobus*	Short	60–100 × 13–16	15– 22 × 3–3½
robustum Tub. and f. *latispora*	*Abies concolor* and *A. amabilis*	Long and medium	150–165 × 30–36	28– 36 × 3– 4
var. *Pini*	*Pinus monophylla*			
(*b*) *deformans* Weir and f. *contorta*	*Pinus ponderosa* and *P. contorta*	Long and variable	166–187 × 27–32	107–119 × 7– 9
lineare (Peck) de Thuem. in *Bifusella* v. Hoehn	*Pinus Strobus* and *P. monticola*	Medium and variable	100–180 × 31–40	each part 25– 35 × 4– 5
Hypodermella				
nervisequia (Fr.) Lag.	*Abies* spp.	Long	62–105 × 13–20	42– 60 × 2½–3½
Abietis-concoloris ?(Mayr) Dearn.	*Abies concolor*	"	120–168 × 18–23	65–120 × 3– 4
macrospora (Hartig) Lag.	*Picea* spp. and *Abies* spp.	Medium and variable	100–140 × 15–28	60– 75 × 2– 4
Laricis Tubeuf	*Larix*	Short	90–110 × 20–25	4-spored 60– 70 × 6
sulcigena (Link) Tubeuf = *pinicola* (Brunch.) R.	*Pinus silvestris*, *P. flexilis*, and *P. contorta*	Short to long	80–150 × 13–30	4- or 8-spored 36– 56 × 3½– 6
montivaga (Petrak) Dearn.	*Pinus contorta*	Short	70–120 × 14–16	35– 48 × 3½– 4
medusa Dearn.	*Pinus Jeffreyi*	"	125–150 × 23–26	52– 75 × 4– 5
ampla (Davis) Dearn.	*Pinus Banksiana*	"	90–165 × 18–30	30– 72 × 3– 6
Lophodermium				
gilvum Rostrup	*Pinus austriaca*	"	75– 80 × 10–12	70– 75 × 2
pinastri (Schrad.) Chev.	*Pinus* spp.	"	90–150 × 10–14	75–140 × 1½– 2
Abietis Rostrup	*Abies* and *Picea*	"	80–140 × 10–16	70–125 × 1½– 2
laricinum Duby	*Larix* spp.	"	90–100 × 9–10	70– 75 × 2½
juniperinum (Fr.) de Not.	*Juniperus* spp.	"	70– 90 × 10–12	65– 75 × 1½– 2
juniperinum Cupressi-thyoides Sacc.	*Chamaecyparis* and *Libocedrus*	"	75– 90 × 9–12	65– 75 × 1½– 2
Thuyae Davis	*Thuja occidentalis*	"	80–100 × 10–12	70– 80 × 1½– 2

of the inverted shape of a tear at the point of falling and apportioned the others between *Hypoderma* and *Lophodermium*.

HYPODERMA spores sub-cylindric, about one-quarter of the ascus-length, sometimes uniseptate.

HYPODERMELLA spores sub-clavate or tear-shaped, one-half to three-fourths of the ascus-length.

LOPHODERMIUM spores filiform in a bundle approximating the ascus-length.

In the table apothecia said to be short are usually less than 2 mm.; medium, from 2–4 mm.; and long, 4–30 mm. or extending the length of the leaf. Sometimes short ones are confluent and long ones interrupted. The sporidia and especially the asci are very variable in size, a fact illustrated in the English edition of Tubeuf's Diseases of Plants, pp. *237, 239*. In *Hypoderma deformans, e.g.,* Dr. Weir found the range of ascus-length 159.5 to 207.2 μ.

RHABDOCLINE PSEUDOTSUGAE Sydow

On *Pseudotsuga taxifolia;* Star, Lane Co., Oreg.; June, 1922; and Sinslaw National Forest; May, 1923. J. S. Boyce: *968, 1142*. Also on Vancouver Isl., B. C.

" Parasitic on trees planted in 1913,—not however on the entire stand. The trees most heavily affected have lost all but their 1922 leaves and these are likely to be attacked and killed this year." Note on *1142* in 1923.—J. S. B.

Stained transections of several leaves through ascocarps differentiated the structures clearly without revealing any apothecial wall. The epiderm splits centrally over the ascocarp or more frequently at its side and remains over it like a partly-open lid. Had it a roof of its own making it would be a good Hypoderma. In *Hypoderma deformans* Weir (J. S. Boyce: *830*) and *Hypodermella montivaga* (Petrak) (Weir: *10,052*) small fertile ascocarps without a discernible wall were observed.

An illustrated account of this interesting fungus was published by Dr. J. R. Weir in Jour. Agr. Research, July, 1917, pp. 99–104 with plate.

HYPODERMA BRACHYSPORUM (Rostrup) Tubeuf

The form found at London, Ont. on *Pinus Strobus* agrees with the figures in Tubeuf's "Studien" and Lind's "Rostrup" and nearly with the description in Rehm's "Nachtrage," p. 1211,—the fruit-measurements of the latter being rather larger. Rehm regards *H. Desmazierii* as described in E. & E. N. Am. Pyr., p. 713, a synonym.

HYPODERMA ROBUSTUM Tubeuf f. **latispora**

On *Abies concolor* (Gord.) Parry; at White Pine, Oreg.; July, 1913; and at Grant's Pass, Sept., 1916. J. R. Weir: *2526, 2542.*

Apothecia hypophyllous, on the midnerve, often its whole length. Asci 8-spored, 90–150 x 30–33 μ. Paraphyses linear, not abundant. Sporidia slipper-shaped, obliquely or quite transversely uniseriate, jelly-sheathed, exclusive of sheath 30–37 x 7–9 μ.

On *Abies amabilis* (Loud.) Forbes; Hood River Co., July, 1923. J. S. Boyce: *1143.* Some of the asci here reach 200 μ in length and the leaves become white throughout.

The type was on *Abies* probably *concolor.* Tubeuf's description, in Studien, op. cit., page 16, and figures, apply well to this material except that his spore-measurements read 30–36 x 3 μ without the jelly covering.

var. **Pini.** On *Pinus monophylla* Torr. & Frem. Minden, Nev.; Sept. 1920; E. Bethel.

Apothecia wider, .5–1 mm., interrupted or continuous the length of the leaf. Asci 2-, 4-, or 8-spored, 135–200 x 28–34 μ. No paraphyses among the mature asci. Sporidia as above.

HYPODERMA DEFORMANS Weir f. **contorta**

On living leaves of the shore pine, *Pinus contorta* Loud., the affected parts becoming yellow or brown and having their limits marked by a transverse dark band. Lookout Mountain, Oreg., Oct., 1921. J. S. Boyce: *829, 830.* Lake Tahoe, Cal.; E. Bethel.

Asci 4- or 8-spored, 150–200 x 30–40 μ, sporidia 60–108 x 6–8 μ, deeply constricted in the middle and septate, usually wider at one end, with jelly-sheath 15–18 μ wide. Paraphyses filiform, not perceptibly thickened at the tip. Witches' brooms, if produced, not noted; one of the twigs in No. *830* shows some hypertrophy.

The type of this destructive fungus is on *Pinus ponderosa* and is well described by Dr. J. R. Weir in Jour. Agr. Research, May, 1916. He reports the production of witches' brooms on the type species which "may weigh as high as 100 pounds and measure 5 or 6 feet in diameter." Examples taken off witches' brooms on *Pinus edulis,* Mancos, Colo., E. Bethel, had asci reaching a maximum length of 306 μ.

HYPODERMA LINEARE (Peck) de Thuem.

Bifusella linearis (Peck) v. Hoehn.

On old leaves, both green and yellow, of *Pinus monticola* Dougl. Bonner Co., Idaho; Sept., 1922; alt. 2700 ft., J. S. Boyce: *1052. P. Strobus,* Huntingdon Co., Pa., L. O. Overholts: *9245. P. contorta,* Tolland, Colo., E. Bethel.

The type is on *Pinus Strobus* collected in New York State. The Idaho collection has larger fruit, some of the asci reaching 200 μ in length and sporidia 50–70 μ in jelly-sheath of 15 μ. Like the type the two halves of each sporidium are joined by a narrow neck 1 μ thick and the asci lack paraphyses.

HYPODERMELLA NERVISEQUIA (Fries) Lagerberg

On *Abies grandis* Lindl., Bellingham, Wash., Aug., 1913; and Priest River, Aug., 1918; J. R. Weir: *2528, 2530a.* Moscow, Idaho; May, 1922; J. S. Boyce: *1055,* not mature. *A. balsamea,* Timagami, Ont., J. H. Faull.

Apothecia hypophyllous on the nerve; usually more or less interrupted but often confluent the length of the leaf. Measurements of the fruit are stated in the table.

Tubeuf, Lagerberg and Lind have figured this species but their figures do not agree well. My concept of the species, formed with the assistance of Mr. W. W. Diehl, on the text of the writers and European material bearing the label, may be different from that of Fries. Rehm gives the asci 70–100 x 15–20 μ; the sporidia 50–60 x 2–2.5 μ.

HYPODERMELLA ABIETIS-CONCOLORIS ?(Mayr) Dearn.

Apothecia hypophyllous along the midnerve of the leaf, interrupted or continuous for its whole length, 15–38 x .6–1 mm.

Asci cylindric-clavate, contracting ellipsoidally in the distal fifth to a truncate tip, 120–168 x 13–14 μ at base to 18–23 μ wide in the widest part. Paraphyses abundant, as long as the asci, filiform, 1–1.5 μ, not thickened at the tip. Sporidia 66–120 x 3–4 μ thick above, 1–1.5 μ at base, ensheathed in thin jelly-layer. The sulcus on the upper side of the leaf is thickly dotted its entire length with spermogonial pycnidia.

On green and yellowing leaves of *Abies concolor* (Gord.) Parry; Baker Co., Oreg.; alt. 5200 ft.; Oct. 1920. J. S. Boyce: *732*. In Colorado: E. Bethel.

This material agrees well with the figures in Tubeuf's "Studien," page 16, of *Lophodermium Abietis-concoloris*, a *nomen nudum* given by Mayr to a species too immature to describe. I risk the supposition that the material under notice is the same as that figured by these authors.

Hypodermella macrospora (R. Hartig) Lagerberg

This has been reported but I have not seen an American species. It is said to be common on *Abies* and *Picea* in northern Europe.

Hypodermella Laricis Tubeuf

Priest River, Idaho; Libby, Montana; J. R. Weir. Wasco Co., Oreg.; alt. 4000 ft.; J. S. Boyce: *967*. Barth. F. Col. *5029*.

Western collections on *Larix occidentalis* Nutt. seem to agree well with Tubeuf's description and plate of this species. The asci with 4 large tear-shaped spores in deep jelly-sheath, about 16 μ broad, are characteristic.

Hypodermella sulcigena (Link) Tubeuf

On *Pinus flexilis* and *P. contorta;* Colorado, E. Bethel.

Hypodermella montivaga (Petrak) comb. nov.

Syn.: *Lophodermella montivaga* Petrak Ann. Myc. 20: 191

On living leaves of *Pinus contorta* Loud. Coeur d'Alene, Idaho; J. R. Weir: *10,052* and *10,146*.

Sporidia in this material 34–45 x 3.5 μ where widest near the upper end and 1–1.5 μ at lower end. On some needles in *10,052* there are minute uncolored pustules in which asci with formed sporidia can be found. In several fertile collections on this host in Colorado by E. Bethel and by Hedgcock & Johnston there are no discolorations marking the position of the ascocarps.

Hypodermella medusa sp. nov.

This, like the last, belongs to von Hoehnel's *Lophodermella.* Apothecia amphigenous, black, 1–3 mm., sometimes confluent or interruptedly confluent up to 30 mm., cleft narrow between the subacute ridge on each side, developing under the epidermis. Asci 8-spored, sessile, wide, 15–18 μ at the base, enlarged upwards, stout-clavate, narrowing ellipsoidally to a thickened truncate tip, 8 μ wide, of variable size,—86 x 24 μ, 143 x 22 μ, 165 x 23 μ,—the longest one observed 176 μ, the widest 29 μ, mostly between 125–150 x 23–26 μ. Paraphyses abundant, narrow, 1.25 μ, ensheathed, longer than the asci, sometimes twice as long, flexed and tangled medusa-like over the top of the asci. Sporidia grumous-hyaline, more than half as long as the asci, in a thick jelly-sheath, 5–9 μ thick, 52–75 μ long. A typical well-developed sporidium exclusive of its sheath is about 30 x 3.5 μ in its upper half and 30 x 1.5–2.5 μ in the lower half,—the contraction being sometimes abrupt near the middle of the spore.

On green and yellowing needles of *Pinus Jeffreyi* "Oreg. Com."; Cisco, Placer Co., Cal.; alt. 5700 ft.; March, 1919. A. S. Rhoads, H. G. Lochmund, and J. S. Boyce: *308.* On *P. ponderosa;* Colorado; July 26, 1917; Hedgcock & Johnston.

Hypodermella ampla (Davis) comb. nov.

On *Pinus contorta* Loud.; Sumpter, Oreg., July, 1913; J. R. Weir: *2520.* Compared with collections by Dr. J. J. Davis on *Pinus Banksiana* Lamb., the paraphyses are longer and more abundant; the distinctly limited whitened portion of the affected leaves and the apothecia are exactly alike. Cfr. *Lophodermium amplum* Davis in Notes on Parasitic Fungi of Wisconsin, 5: 695. Dr. Davis queries whether this may not be in Lagerberg's *Hypodermella. H. sulcigena* on *Pinus silvestris,* collected by Lagerberg, is microscopically similar except that in the latter the sporidia are wider above and obtusely bent near the base. Macroscopically they seem distinct.

LOPHODERMIUM GILVUM Rostrup

On *Pinus austriaca* Hoss.; old stock in a nursery; Washington Co., Oreg.; Feb., 1921. J. S. Boyce: *805.* "The stock was probably imported."—J. S. B.

LOPHODERMIUM PINASTRI (Schrad.) Chev.

On *Pinus* spp. This is the commonest species.

LOPHODERMIUM ABIETIS Rostrup

On *Abies lasiocarpa* (Hook.) and *Picea Engelmanni* Engelm.; J. R. Weir: *6955* and *9175*. On *Picea* sp.; Essex Co., N. Y.; H. D. House.

Saccardo and Rehm omit this but Rostrup and Lind both regard it as a valid species. In Denmark they found it on *Taxus* and *Pseudotsuga* and common on *Abies* and *Picea*. Its asci and sporidia are somewhat shorter than those of *L. pinastri* and its paraphyses are straighter and less thickened at the top.

LOPHODERMIUM LARICINUM Duby

On *Larix laricina* (du Roi) Koch. Lake Timagami, Ont., July 15, 1923; G. D. Darker. Sporidia reaching max. 100 μ in length; paraphyses exceeding the asci and strongly hooked.

LOPHODERMIUM JUNIPERINUM (Fries) de Not.

This species is not rare. It and the form *Cupressi-thyoides* Sacc. are represented in E. & E. N. Am. Fungi No. *999*. What seems to be a similar form was collected by J. S. Boyce in Plumas Co., Cal.; alt., 4500 ft.; June, 1919; on *Libocedrus decurrens* Torr.

LOPHODERMIUM THUYAE Davis

Dr. C. H. Peck collected a specimen in the Adirondacks which he labelled *Hysterium pinastri* var. *Thujae*, unpublished, that seems the same as *L. Thuyae* Davis, described and illustrated in Notes on Parasitic Fungi of Wisconsin, Tran. Wisc. Acad. Sci. 20: 424. It is similar to, but smaller than, *L. pinastri*.

PERIOSPOREAE

Dimerosporium Tsugae sp. nov.

Subiculum of thin branching anastomosing mycelium, 3–4 μ thick, giving a smoky cast to the leaf-surface, hypophyllous. Perithecia gregarious, unappendaged, sometimes with 2 or 3 short rigid mycelioid branches, dark-brown, globose, 75–90 μ; cells of the wall quadrate, 6–8 μ. Asci very variable in shape, battledore-like to cylindric, 36–60 μ long, 12–25 μ wide. Paraphyses? Spo-

ridia biseriate to conglobate, hyaline, uniseptate, sometimes nucleate in one or both cells, 13–21 x 3½–5 μ, upper cell usually larger.

On leaves of *Tsuga heterophylla* (Raf.) Sarg., Pierce Co., Wash., July 25, 1921. J. S. Boyce: *832.* Also *604* at Sol Duc Hot Springs, Wash.; *699* at McCredie Hot Springs, Wash.; and *1152* in Lane Co., Oreg. Mr. Boyce writes that this species is not on needles of the season, that it is immature on needles a year old and mature only on needles two years old.

A form on *Abies grandis* Lindl., Government Soda Springs, Wash., July, 1920, J. S. Boyce: *584,* so far as it has developed cannot be separated from that on *Tsuga.* No. 832 (J. S. B.) is the type collection. It was compared with the types of *Dimerosporium balsamicola* (Pk.) Sacc. and the latter's similar, *Asterina nuda* Pk. Their subicula are different and their spores much smaller than those of No. *832.*

MELIOLA COOKEANA Speg.

On living leaves of *Callicarpa americana* L., Miami, Fla., March, 1923, L. W. Nuttall.

The asci are mostly 2-spored but some of them are 4-spored. In the latter the sporidia are a very distinct pair of pairs.

Microthyrium Thuyae sp. nov.

Perithecia hypophyllous, scattered, dimidiate, 2–3 per sq. cm., sub-hemispheric then depressed, ostiolate, dark-brown, shining, 100–120 μ, cells of perithecial wall seriate, quadrate, mostly about 5 μ in diameter; exceptionally with a strand or two of brown hyphae attached. Asci fusoid, 30–34 x 8 μ; aparaphysate. Sporidia hyaline, fusoid, 9–11 x 3–4 μ.

On living leaves of *Thuja plicata* Don, not causing noticeable injury. Hood River Co., Oregon National Forest, alt. 3600 ft., July 25, 1923. J. S. Boyce: *1153.*

HYPOCREALES

DOTHIDEA BACCHARIDIS Cke.

Examination of a collection of branches of *Baccharis halimifolia* L. made by Roy Latham, Orient, N. Y., May, 1923, enables me to enlarge the description of *Dothidea Baccharidis* Cke. in Grev. XI: *108* and the addendum in Ell. & Evht., N. Am. Pyr., page 612.

The asci, p. sp., are 120 x 10–11 μ surrounded by long linear paraphyses some of them twice the length of the asci. Most but not all of the sporidia are distinctly larger in the upper cell.

Dothidella Castanopsidis sp. nov.

Stromata .2–.5 mm. in diameter, epiphyllous, dark-brown, erumpent, gregarious, 5–40 centrally clustered on spots which are circular when not confluent, 3–5 mm. in diameter, gray-brown, definitely limited with a wide red-brown border diffusing into the surrounding green tissue. Lower surface of the leaf not visibly altered. Locules 1–5 in a stroma, globose, 75–100 μ. Asci 8-spored, fusoid to sub-clavate, sub-acute at both ends, 45–75 x 9–15 μ. Paraphyses? Sporidia biseriate, or sometimes crowded towards the middle of the ascus, 1-septate, usually arcuate, sometimes straight, 20–27 x 3 ½–5 μ.

On living leaves of *Castanopsis chrysophylla* (Hook.) D. C. Star, Lane Co., Ore., alt. 900 feet, June 22, 1921, and at Rujada, Lane Co., June, 1923. J. S. Boyce: *840, 1178.*

Phyllosticta castanicola E. & E. On the same host and in the same kind of stromata, spores 3–3.5 x 1–1.25 μ, Eula, Lane Co., Ore., June, 1920. J. S. Boyce: *538,* and in Klamath Co., Sept., 1921. J. S. Boyce: *1060.* The describers of this form state in Proc. Acad. Phil., 1895, page 431, "The tough, almost sclerotoid perithecia indicate that this may be the stylosporous stage of some Phyllachora or Dothidaceous fungus."

PHYLLACHORA OXALINA E. & E.

The conidial stage of this species was described in Jour. Myc. III: 41, 1887. Gregarious, minute, tuberculiform pycnidia, bearing stylospores, oblong-fusoid, hyaline, 2-nucleate, then 1-septate, 7–8 x 2–3 μ.

In a colony of *Oxalis stricta* L. in Aug.–Sept., 1923, I found the conidial stage on the leaves, and two months later on the stromatically blackened stems of plants in the same colony, ascigerous locules that I take to be the mature stage of the fungus not hitherto described so far as I know.

Locules sparsely scattered in the blackened cuticle of the stems. Asci 8-spored, fusoid, 40 x 9 μ. Sporidia hyaline, obliquely uniseriate, narrowly elliptic, nucleate near each end, 8–9 x 2.75–3 μ.

London, Ont., Oct.–Nov., 1923. Dearness: *2518* f.

Rhopographus nucleatus sp. nov.

Stromata elongate, brown, erumpent, .5–4 x .2 mm. Perithecial cells 3–40 in a single series in the stroma, 70–120 μ in diameter. Asci clavate, curved, paraphysate, 55–75 x 10–12 μ. Sporidia hyaline, clavate-fusoid, a large oil-drop, sometimes 3 or 4, in each spore, septate, finally 3 or more obscure septa, 23–28 x 5–8 μ, mostly about 25 x 7 μ.

In dead culms of *Elymus virginicus* L. London, Ont., Sept., 1923. Dearness: *5373*.

SPHAERIALES

ERIOSPHAERIA ALLIGATA (Fr.) Sacc.

An *Eriosphaeria* on decaying Sassafras trunk; Orient, N. Y., Jan., 1923. Roy Latham: *415*. This fungus grew on the rotten wood under the loosened bark. It meets in large part the requirements of the description of *Eriosphaeria alligata* in Syst. Myc. 2: 445 and Syll. 1: 597. It has the yellowish, bi-nucleate, constricted sporidia and the deciduous ostiolum of the flat or umbilicate perithecium. It differs in the perithecia not being distinctly collabescent and possibly in sometimes having a dense subiculum. The most conspicuous feature in this collection is the red, rough, flat surface of the perithecia with the brown hyphal appendages, 200 x 4–5 μ. Asci 75–90 μ; paraphyses numerous, branching, longer than the asci. Sporidia 1-septate; monostichous or in some of the asci sub-biseriate, 15–21 x 4.5–6 μ.

Another collection, at Orient, Feb., 1924, was under the loosened bark of *Sambucus* sp.

ROSELLINIA LIGNIARIA (Grev.)

On bare blackened wood, a *Rosellinia* agreeing well with *ligniaria* except that the asci are only 45–60 μ instead of the usual 75–80 μ of the type. Sporidia 10 x 7 μ. Perithecial bristles 15 to 40 mostly 20 x 4 μ.

Collected at Greenport, N. Y. Roy Latham: *551*.

TEICHOSPORA MAMMOIDES E. & E.

var. **Opuntiae** Dearn. & Barth., var. nov.

On *Opuntia echinocarpa* Engelm., San Bernardino, Cal., Apr. 23, 1923. E. T. Bartholomew.

The type is on *Sarcobatus*. This fine form on *Opuntia*, besides being on a different host, varies from the type in the character of the sporidia which are nearly uniformly 3-septate and constricted at the middle septum.

Lophiostoma Elymi sp. nov.

Perithecia erumpent, carbonaceous, firm, rough, shining, sometimes coalescent, 350–750 μ long, 150–300 μ wide; ostiolum at its best development 170 μ long, 150 μ high. Paraphyses abundant, linear, longer than the asci. Asci stipitate, delicate, fusoid-clavate, mostly 4-spored, sometimes with only 2 developed spores, 60–100 x 7–12 μ. Sporidia hyaline, acute, 1-septate, not appendaged, slightly constricted, uniseriate or sub-biseriate, mostly 4-nucleate, 30–35 x 6–9 μ.

In dead culms of *Elymus virginicus* L. London, Ont.; Sept., 1923. Dearness: *5372*.

L. clavisporum E. & E., also on *Elymus*, has colored 3–5-septate spores.

Mycosphaerella Chenopodii Dearn. & Barth., sp. nov.

Perithecia very thickly scattered, 30 or more per sq. mm., immersed, hemispheric, perforate or briefly ostiolate, black, shining, 80–100 μ. Asci few, aparaphysate, fusoid, 45–55 x 9–12 μ. Sporidia hyaline, uniseptate, slightly constricted, grumous, inequilaterally oblong, ends rounded, 16–21 x 5–6 μ.

On dead stems of *Chenopodium leptophyllum* Nutt.; Stockton, Kan.; June and July, 1923. E. Bartholomew: *8177, 8257*.

PHYSALOSPORA ERRATICA (C. & E.) Sacc.

On dead apple branches, Orient, N. Y., Roy Latham: *969*. If the identification of this collection is right the description in E. & E. N. Am. Pyr., p. 306, may be completed as follows: Perithecia 340 μ, depressed-globose, merely perforating the epidermis and coming off with it. Asci clavate, 150–200 x 15–20 μ.

Anthostomella longispora Dearn. & Barth., sp. nov.

Perithecia scattered, buried under the blackened surface which is minutely ruptured, no pustulation or projecting ostiola to indicate their position, 225–350 μ in diameter. Asci cylindric, 90–

100 x 8.5–10 μ, weakly paraphysate. Sporidia brown, elongate-elliptic, 21–27 x 5–7 μ.

On decorticated *Populus Sargentii* Dode; Stockton, Kan.; June 25, 1923. E. Bartholomew: *8223.*

DIAPORTHE BINOCULATA Ell. var. **Clethrae** var. nov.

This is distinguished from the type by the larger cinereous disc of the stroma and smaller asci. The latter are 60–75 x 10–12 μ. Sporidia 12–15 x 7–7.5 μ.

On dead stems of *Clethra alnifolia* L. Greenport, N. Y.; April 1923. Roy Latham: *1055.*

EUTYPELLA GLANDULOSA Cke.

Near Orient, N. Y., Roy Latham has collected *Eutypellae* on *Ailanthus, Akebia, Amelanchier, Robinia, Sassafras, Quercus,* and *Vitis* which can hardly be separated except by their hosts. And while they are referred to *Eutypella glandulosa* Cke. this species is separated by rather obscure differences of essential characters from *Eu. deusta* E. & E., *Eu. capillata* E. & E., and *Eu. microcarpa* E. & E. Their sporidia range somewhat under 4 x 1 μ; their asci, perithecia and stromata are similar; and their perithecia impress the wood.

VALSARIA VITICOLA (Schw.) Sacc.

A collection of this species in good fruit on *Vitis vulpina* L. at Stockton, Kan., July, 1923, by E. Bartholomew (*8241*) affords a basis for completing the description quoted in N. Am. Pyr., p. 562.

Stromata irregularly hemispheric, .3–.5 mm.; ostiola obtuse and obscure. Asci cylindric, 95–130 x 9–11 μ; paraphyses linear, equal to or longer than the asci. Sporidia uniseriate, uniseptate, brown, 12–18 x 7–9 μ.

NUMMULARIA DISCRETA (Schw.) Tul.

On *Malus Malus* (L.) Brit., Orient, N. Y., Roy Latham: *1062;* on *Amelanchier,* Warren Co., N. Y., S. H. Burnham: *47;* Stockton, Kan., E. Bartholomew: *8152.*

Dr. Bartholomew writes that this is a very destructive parasite. " It threatens to destroy my domesticated juneberries by attacking them at or below the surface of the ground. The effect is to make

them so brittle that they can be easily snapped off at the ground level."

PHOMATALES

PHYLLOSTICTA GAULTHERIAE E. & E. f. **shallon**

On *Gaultheria shallon* Pursh, Lane Co., Oreg., June, 1923. J. S. Boyce: *1179*.

The type was on *G. procumbens* L. This conspicuous form differs in its pycnidia being epiphyllous only and its spores densely granular and globose, 5–6.5 μ. The spots, .3–1 cm., are pale-brown below and dark-brown above becoming white in the center.

PHYLLOSTICTA CRUENTA (Fr.) Kickx.

"Spots subcircular or oblong, 3–10 mm., nearly blood-red fading out in the center. . . . Sporules oval or elliptical, granulose, 12–15 x 6–9 μ."—Ell. & Evht. Phyllostictas of N. America, p. 70.

Var. PALLIDIOR (Pk.) Davis

N. Y. Mus. Bull. 105: 26. 1905.

Wisc. Ac. Sc. 17: 865. 1914.

Exsic. F. Col. 433, 1336, 4652.

Spores globose or sub-globose, 9–12 μ, on *Smilacina* (*Vagnera*) spp. and *Polygonatum*.

Var. **longispora** var. nov.

Spots with a narrow red border, center pallid to white, becoming deciduous. Pycnidia 150–200 μ, oblong-elliptic or fusiform, rounded at the distal, sub-acute at the proximal end, sometimes rather acute at both ends, 17–24 x 6–9 μ on long conidiophores.

On *Polygonatum biflorum* (Walt.) Ell. Orient, N. Y., Aug., 1923. R. Latham: *1342*.

About twenty of these cruentous collections taken in Canada and five of the States were examined. Three of them on *Polygonatum* are the last named. The common form is var. *pallidior*.

Phoma Akebiae sp. nov.

Pycnidia erumpent, large, 225 μ at base, 200–300 μ high, conical, black, shining. Conidia hyaline, oblong, 4–10 x 2.75 μ mostly 5–6 μ long, thinly ensheathed in mucus, on long conidiophores mostly about 45 x 2 μ, simple or some of them sparingly branched near the base.

On dead stems of *Akebia quinata* Decaisne, associated with a form of *Schizoxylon Berkeleyanum;* Orient, N. Y.; May, 1923. R. Latham: *1124.*

Phoma Cynoglossi sp. nov.

Pycnidia nearly black, thickly scattered, sub-cuticular, erumpent, perforate, 150–200 μ. Conidia hyaline, oblong, 5–7 x 2.5 x 3 μ.

On dead stems of *Cynoglossum officinale* L. Washington Co., N. Y., May, 1917. S. H. Burnham: *176.*

Phoma spermoides sp. nov.

Pycnidia sub-cuticular, thickly and extensively scattered, dark, small, 80–120 μ, sub-globose, contracted upwards, perforate; wall membranaceous consisting of a single layer of cells averaging 8–9 μ in diameter. Conidia hyaline, sub-allantoid, 3–4 x 2.5–2.75 μ, nucleate at each end.

On dead stems of *Thalictrum* sp.; Orient, N. Y.; March, 1923. Roy Latham: *1130. P. thalactrina* Sacc. has much larger spores.

Macrophoma Oenotherae-biennis sp. nov.

Pycnidia black, hemispheric, thickly scattered, conically pointed and completed with a distinct ostiolum, sometimes depressed, 175–200 μ in diameter. Conidia hyaline, continuous, fusoid or slipper-shaped, grumous and guttate, 21–24 x 5–8 μ, on very short conidiophores.

On dead capsules and stems of the inflorescence of *Oenothera biennis* L.; Orient, N. Y.; Dec., 1922. Roy Latham: *514.*

MACROPHOMA ULMICOLA E. & E. Jour. Myc. 9: 164

M. ulmicola Dearn., Mycologia **9:** 353, is the same species. The publication of the former was overlooked when the latter was published.

Dendrophoma Syringae sp. nov.

Pycnidia thickly scattered, flask-shaped and flat based, coming off with the epiderm which is raised into conical pustules perforated by the short, black ostiola, and leaving pits in the lower stratum of the cortex, .5–.7 mm. wide. Conidia allantoid, hyaline, 4–6.5 x 1–1.5 μ on branched conidiophores 1.5 μ thick making a stratum about 30–45 μ deep.

On dead branches of *Syringa vulgaris* L. Washington Co., N. Y., May, 1817; S. H. Burnham: *174*. Also at Greenbush, N. Y.; H. D. House.

Sphaeropsis Akebiae sp. nov.

Pycnidia thickly scattered in the cortex, raising the cuticle into pustules and perforating it by their ostiola; in section the white lining of sporophores contrasts strongly with the dark wall of the pycnidia which are 170–250 μ in diameter. Conidia pale-brown, mostly obovoid but varying in shape and size,—24 x 9, 21 x 12, 15 x 12 μ.

On dead stems of *Akebia quinata* Decaisne. June, 1923; Long Island, N. Y. R. Latham.

Sphaeropsis Amelanchieris sp. nov.

Pycnidia very thickly scattered, surrounding the branch, pustulate-erumpent, .25–.5 mm. in diameter. Conidia pale-brown, oblong with rounded ends, enucleate, continuous, exceptionally uniseptate, 23–30 x 9–10 μ, on conidiophores 3–4 μ thick. Curved stylospores 15–25 x .5 μ also present.

On dead branches of *Amelanchier canadensis* (L.) Medic Orient, N. Y., Dec., 1923. Roy Latham: *532*.

The conidia are longer and narrower than those of other Sphaeropses on pomaceous hosts with which they were compared.

Sphaeropsis baccharidicola sp. nov.

Pycnidia cortical, closely seriate in lines determined by the fibrovascular strands, rupturing the cuticle, rough, black hemispheric, perforate, sometimes minutely papillate, 300 μ. Conidia brown, obovoid to oblong-elliptic, 18–24 x 9–12 μ on conidiophores 10–12 x 3 μ.

On stems of *Baccharis halimifolia* L. on the same plant with *Dothidea Baccharidis* Cke. Orient, N. Y.; May, 1923. Roy Latham: *1143*.

Sphaeropsis Prosopodis Dearn. & Barth., sp. nov.

Pycnidia in the outer bark which is ruptured but scarcely raised above the minute ostiola, very thickly scattered, 8–12 per sq. mm., circular, depressed, walls thin, 170–225 μ in diameter. Conidia brown, finally dark-brown, oblong-elliptic, of uniform content, variable in size, 15–27 x 9–15 μ, mostly 18–20 x 11 μ.

On dead branches of *Prosopis juliflora* (Sw.) DC. Wichita Falls, Texas; May 9, 1923. E. Bartholomew: *8062*.

Sphaeropsis Tecomae sp. nov.

Pycnidia as thickly congregated as possible, sometimes thinly scattered, erumpent or exposed through rifts in the bark or small perforations, 300–350 μ in diameter. Conidia oblong-elliptic, brown, 18–22 x 9–10 μ on conidiophores nearly of their own length.

On dead branches of *Tecoma radicans* (L.) Juss. Orient, N. Y., Jan., 1923. R. Latham: *672, 1185*.

Coniothyrium Bartholomaei Dearn. & Barth., sp. nov.

Beginning as a bright orange disc, one to several mm. in diameter and penetrating to the interior cavity of the stem, a depth of 2.5–6 mm., the spot develops into an extensive, yellowish-gray canker reaching 9 x 3 cm. Centers of fructification in concentric arrangement appear as dark spots, 1–3 mm., both externally and in the stem cavity, developing from masses of hyaline hyphae, 3 μ thick, finally throwing off the ectoderm and exposing the single or confluent black masses of conidia and hyphae, 1–2 mm. broad and 1 mm. deep. Between these external layers there are one or more immersed layers of such fructifications up to 3 x 2 cm. in area; the intervening tissue is more or less shrunken and blackened. Conidia brown, globose to sub-elliptic, minutely echinulate, 6–8.5 μ.

On stems of *Yucca Whipplei* Torr. San Bernardino Co., Calif., April 23, 1923. Named in honor of Dr. E. T. Bartholomew, the collector.

Externally resembling but quite different from *C. concentricum* Sacc.

(?) **Haplosporella rhoina** Dearn. & Barth., sp. nov.

Stromata rather thinly scattered, raising the bark into obtuse, concolorous pustules, .5–1 mm. through base, 100–150 μ high, circular or elongate, immersed in the cortex but not reaching the wood, slaty-black in section. (?) Pycnidia locellate, separated by thin partitions, 15–25 μ thick. Conidia brown, continuous, oblong with rounded ends, 15 x 6–7 μ on long narrow conidiophores, 15–30 μ.

On dead branches of *Rhus glabra* L. Stockton, Kan.; July, 1923. E. Bartholomew: *1293*.

BOTRYODIPLODIA COMPRESSA (Cke.) Sacc. f. **Toxicodendri**

The erumpent, cespitose pycnidia and some of the conidia agree with the description of *Diplodia compressa* Cke. This differs in having mostly constricted conidia some of them remarkably unequal in the size of the two cells that form the spore,—the disparity reaching 15 x 15 μ in the upper and 7–6 μ in the lower cell of the same spore. Some of the spores are, however, non-constricted measuring 21 x 7–8 μ.

On *Rhus Toxicodendron* L. Orient, N. Y., March, 1923. Roy Latham: *962*.

Kellermannia major Dearn. & Barth., sp. nov.

Pycnidia subcuticular, scattered, appearing gray through the yellowish cuticle, no ostiolum, often a dark speck in the center of the disc, .5–.8 mm. in diameter. Conidia hyaline, granular, when fully developed distinctly 3-celled, the median cell about half the size of the terminal ones, nucleate, bearing distally one or two prong-like extensions or aristae, 55–75 x 11–14 μ, aristae 15–18 x 3–4 μ.

On stems of *Yucca Whipplei* Torr.; San Bernardino, Calif., April 23, 1923. Coll. Dr. E. T. Bartholomew.

Hendersonia Grantii sp. nov.

Pycnidia embedded in the tissue between the fibro-vascular bundles of the sheath, dark but obscured by the ectoderm which is not raised into pustules but merely minutely perforated, membranous, 150–175 μ. Conidia elliptic, brown, 1- or 2-, mostly 3-septate, 12–15 x 6–8.5 μ.

On sheaths of *Phragmites* sp.; Langley, Wash.; Feb., 1923. J. M. Grant: *5082*.

Differs from *H. Phragmitis* Desm., which has papillate ostiola, longer spores and larger, brown-banded pycnidia.

CAMAROSPORIUM ASTERICOLUM Ell. & Barth., var. **latispora** var. nov.

The type is on *Aster* stems and has spores 4.5–7 μ wide. This variety is on *Artemisia* and has spores reaching a width of 11 μ. Collected at Langley, Wash., April, 1923, by J. M. Grant: *5093*.

Dichomera Clethrae sp. nov.

Stromata thickly scattered, cortical, erumpent, bordered by the raised bark and coming off with it leaving no mark on the wood, 340–856 μ in diameter, containing up to 10 or 12 but mostly 5 or 6 conidia-bearing locules. Conidia brown, sub-globose, 3- to 5-septate, mostly about 12 μ in diameter on short conidiophores 2 μ thick.

On dead stems of *Clethra alnifolia* L. Greenport, N. Y., April, 1923. Roy Latham: *1044b.*

Externally like *Steganosporium fenestratum* (E. & E.) Sacc. on the same host.

SEPTORIA ASCLEPIADICOLA E. & E. f. **syriaca**

On *Asclepias syriaca* L. Gatesburg, Pa., Aug., 1923. C. R. Orton, L. O. Overholts: *8753.*

The spots are black-brown above, paler beneath, circular, bounded by a dark ridge. Pycnidia innate, opening above, possibly also beneath, 64–78 μ. Sporules straight or curved, continuous, even, 24–32 x 2 μ.

The type is on *Asclepias incarnata;* the differences may be due to host relations.

SEPTORIA CIRCINATA E. & E.

Syn.: *Septoria curvispora* E. & E. Label on N. A. F. 3720; Proc. Phil. Acad. 1895, p. 434.

(?) *Cylindrosporium acerinum* Tr. & Earle, Proc. Cal. Acad. 1895, p. 732.

(?) *Phleospora curvispora* (E. & E.) Petrak Ann. Myc. **20:** 210. 1922.

Exsiccati: N. A. F. *3270, 3368;* F. Col. *773, 974, 1780, 4477.*

Septoria circinata E. & E. was published in Proc. Phil. Acad. in 1894, p. 367. The study of several ample western collections—J. S. Boyce: *731, 1092, 1164,* etc.—on *Acer circinatum* and *A. macrophyllum* has led to the conclusion that they are this species and that the names listed above or at least the first two are synonyms. The *Acer glabrum* records in my copies of the exsiccati should be *A. circinatum.* The authors of *S. curvispora* (op. cit.) retired it to a mere variety of *S. circinata.* I failed to find

that the type of *Cylindrosporium acerinum* Tr. & Earle is extant; the doubt of its status is based on the description. The co-type of *Phleospora curvispora* seems to me to be *Cylindrosporium consociatum*,—see page 172 of this paper.

Septoria Radiculae sp. nov.

Spots scattered, circular, .5–3 mm. in diameter, white, with diffuse, dark-brown border, slightly or not at all paler beneath. Pycnidia epiphyllous, visible beneath, 2 to 20 on a spot, black, 50–140 μ. Sporules hyaline, continuous, linear, straight or flexuous, 36–45 x 1.5 μ. Many of the spots when held to the light are seen to be partly surrounded by a pale rim simulating the work of a leaf-miner.

On living leaves of *Radicula palustris* (L.) Moench. Southold, N. Y.; Sept., 1922. Roy Latham: *685*.

LEPTOSTROMATALES

Leptothyrium Chenopodii Dearn. & Barth., sp. nov.

Pycnidia black, very numerous, scattered along the valleys between the ridges of the stem, sometimes so thickly as to be confluent, flat, circular, perforate, 70–250 μ in diameter, 80–100 μ high. Conidia sub-hyaline, fuliginous in the mass, minutely rough, elliptic to globose, 5–6 μ.

On *Chenopodium hybridum* L.; Stockton, Kan.; July, 1923. E. Bartholomew: *8259*.

Leptothyrium Lactucae Dearn. & Barth., sp. nov.

Pycnidia evenly and thickly scattered surrounding the stems, circular to elongate, perforate with dark rim, 200 μ in diameter, elongated examples up to 1 mm. Conidia hyaline, elliptic with one or both ends sub-acute, 2- to 3-nucleate, 6–12 x 3–4 μ, mostly about 8 x 3.5 μ, on obtuse conidiophores, 3–10 x 2 μ.

On *Lactuca scariola* L. Stockton, Kan.; June, 1923. E. Bartholomew: *8198*.

Leptothyrium Smilacis sp. nov.

Pycnidia very thickly scattered, rather deeply covered, dark-brown, circular to oblong-elliptic, .3–2 mm. long by .3–1 mm. wide. Conidia hyaline, oblong with acute ends, continuous, 6–12 x 3 μ on conidiophores up to 12 μ in length.

On twigs and branchlets of *Smilax rotundifolia* L. Orient, N. Y.; Feb., 1920. Roy Latham: *1339.*

Piggotia depressa sp. nov.

Pycnidia sub-cuticular, black, hypophyllous, scattered, cespitose or stromatic, perforate, 80–120 μ. Spores hyaline, continuous, straight, or slightly curved, 2–3 x 1 μ.

Associated with, probably a spermatoid stage of, *Fusicladium depressum* (B. & Br.), on living leaves of *Angelica Lyallii* S. Wats.; Alpine, Mont., Aug., 1921; E. Bartholomew: *7339;* also on *A. atropurpurea* L. London, Ont. Dearness: *329.*

Leptothyrella Lathami sp. nov.

Pycnidia black, circular to elongate, .1–1 mm., thickly scattered, erumpent through a thin layer of wood fibers, rough. Conidia hyaline, oblong with rounded ends, 1-septate, 6–9 x 2.5–3.25 μ on long loosely branching conidiophores up to 100 x .75 μ.

On decorticated *Robinia Pseudo-Acacia* L. Orient, N. Y.; Feb., 1923. Roy Latham: *986.*

Leptothyrella Robiniae Dearn. & Barth., sp. nov.

Pycnidia erumpent, thickly scattered, sometimes several confluent simulating stromata, perforate, 100–300 μ in diameter. Conidia hyaline to amber-colored, uniseptate, oblong-elliptic, constricted, 9–11 x 3 μ on obscure conidiophores or sessile.

On dead young twigs of *Robinia Pseudo-Acacia* L. Stockton, Kan.; July, 1923. E. Bartholomew: *8254.*

The inner cortical layer subjacent to the fungus is usually aeruginous.

Leptostromella Panici sp. nov.

Pycnidia minute, 50–250 x 50 μ, innate, amphigenous but more numerous on the upper side, close together in lines between the veins. Conidia hyaline, linear oblong, 18–22 x 2.75–3 μ, 3-septate, on short conidiophores.

On living and languishing leaves of *Panicum hians* Elliott. Orangeburg, S. C.; Aug. 15, 1905. R. Latham: *667.*

Externally similar to *L. septorioides* S. & R.

Phragmopeltis Phragmitis sp. nov.

Stromata linear, becoming black, emergent through a hysteroid cleft exposing the indistinct locular stomata, .5–2 x .175 mm. Locules in a single series, 140–170 μ in diameter. Conidia tardily fuliginous or darker, oblong with rounded ends, often sub-clavate, 3-septate, uniform or nucleate between the septa, 20–30 x 4.5–5 μ, on conidiophores 15 x 2.5–3 μ.

On dead culms of *Phragmites* sp. Langley, Wash.; Feb., 1923. J. M. Grant: *5082*.

MELANCONIALES

Gloeosporium Betulae-papyriferae Dearn. & Overh., sp. nov.

Spots circular, 3–15 mm., becoming confluent, on the upper side the chocolate-brown central part surrounded by a gray-brown region and completed by a darker margin, 1–1.5 mm. wide, on the lower side uniform butternut brown. Acervuli hypophyllous, blister-like, yellowish, irregular, circular or angular, 50–500 μ. Spores hyaline, oblong, 3.5–5 x 1.75–2 μ.

On living leaves of *Betula papyrifera* Marsh. Lamar, Pa.; Sept., 1922. L. O. Overholts: *8710*.

This is different from any of the other five *Gloeosporia* inhabiting *Betulae,* seeming nearest *G. betulicola* Sacc. & Dearn. which has larger spores.

Gloeosporium Chamaedaphnis sp. nov.

Spots epiphyllous, numerous, circular, scattered, brown, .5–3 mm. Acervuli circular or irregular, epiphyllous, black, 1–20, mostly 2–3 on a spot, 80–200 μ. Conidia hyaline, fusoid to limoniiform, 15–18 x 7–9 μ.

Conspicuously mottling the living leaves of *Chamaedaphne calyculata* (L.) Moench. London, Ont.; Oct., 1910. Dearness: *3405*.

Gloeosporium hysterioideum Dearn. & Barth., sp. nov.

Spots large, irregularly circular, becoming confluent and finally covering most of the leaf, amphigenous, livid-arid above and pale-brown beneath, average 1.5–2 cm., lacking definite border and having a paler central area of 5–8 mm. in which the acervuli appear. Acervuli epiphyllous, visible on the lower side when the leaf is held

towards the light, amber colored, sub-circular, 80–500 μ in diameter, raising the cuticle and hysteroidally rupturing it. Conidia hyaline, globose to pyriform, 15–21 x 13–15 μ on short conidiophores 4–5 μ thick, often accompanied by bacillar conidia, 4–8 x 1.5 μ, on thinner basidia. In some of the more recent spots only the latter form was found.

On living leaves of *Acer saccharum* Marsh. Near Cincinnati, Ohio; Sept., 1922. E. Bartholomew: *7861*.

Gloeosporium Lathami sp. nov.

Spots 4–7 mm. becoming confluent, not definitely bordered, generally following the veins of the leaf, yellow-brown, quite pale on the lower side of the leaf but plainly visible if held to the light. Acervuli numerous, dark, covered by modified leaf-cells, epiphyllous, 90–250 μ in diameter. Spores hyaline, bacillar, 2.5–3 x 1–1.25 μ.

On living leaves of *Quercus stellata* Wang. Orient, N. Y.; Sept., 1817. Roy Latham: *829*. "Conspicuous in the fall; one tree in the center of a wood was covered with it."—R. L.

Gloeosporium Osmaroniae sp. nov.

Maculae amphigenous, mostly epiphyllous, scattered, brown with darker border, turning arid or whitish in the center or mottled with small white spots, sub-circular to triangular, taking shape from the limiting veinlets, reaching 15–8 mm. Acervuli pale, becoming brown on the arid areas, amphigenous but mostly epiphyllous, 90–200 μ. Conidia hyaline, grumous or guttate, 5–7.5 x 3–3.5 μ.

On leaves of *Osmaronia cerasiformis* (T. & G.) Greene. Seattle; Aug., 1892. C. V. Piper.

Myxosporium alboluteum Dearn. & Barth., sp. nov.

Acervuli seriate to thinly scattered, large, .5–2 mm. in diameter at base, .3–.4 mm. high, erumpent, an inner covering layer of blackened cells under the finally loosened cuticle. Conidia issuing in egg-yellow masses, hyaline, elongated-elliptical to fusoid, mostly 2-nucleate, 12–24 x 4–5 μ on conidiophores 10–30 x 2.5 μ.

On dead bark of *Populus Sargentii* Dode. Stockton, Kan.; July, 1923. E. Bartholomew: *8266*.

Myxosporium Oenotherae sp. nov.

Acervuli reddish-brown, circular to elliptic, thickly scattered and intermingled with *Macrophoma,* circular forms 200–300 μ, elongated ones 300–500 μ, perforate centrally or often with more than one perforation or a short slit. Conidia hyaline, elliptic, acute at the ends, 6–11 x 3 μ.

On dead capsules of *Oenothera biennis* L. Orient, N. Y.; Dec., 1922. Roy Latham: *514.*

Myxosporium Tiliae sp. nov.

Acervuli sub-cuticular, raising the cuticle into circular or irregular oblong blisters, .5–2.5 mm. Conidia olivaceous in the mass, hyaline, oblong-elliptic, 9–10 x 3–4 μ.

On dead branchlets of *Tilia americana* L. Hudson Falls, N. Y.; March, 1915. S. H. Burnham: *19.*

Quite distinct from *M. fumosum* E. & E. on the same host.

Myxosporium stellatum sp. nov.

Acervuli dark gray, raising the cuticle in usually broadly elliptic flat elevations and rupturing it in a stellate or lacerate manner, .5 mm. in diameter. Conidia hyaline, straight or slightly curved, narrowed at the ends, 7–10 x 1.5 μ.

On dead twigs of *Quercus velutina* Lam. Cohoes Falls, N. Y.; March, 1910. S. H. Burnham: *80.*

Colletotrichum fusarioides (Ell. & Kell.) O'Gara comb. nov.

Three different collections of leaves and follicles of *Asclepias syriaca* L. were found to bear a fungus agreeing with the descriptions of:

Gloeosporium fusarioides E. & K. Jour. Myc. **1:** 3. 1885.

Gloeosporium Moellereanum Thuem. var. *folliculorum* Sacc. Syll. 18: 458. 1906.

Colletotrichum salmonicolor O'Gara, Mycologia **7:** 40. 1915.

The marginal setae are scanty and indeed not commonly present, therefore the fungus will be sought as often under *Glocosporium* as *Colletotrichum.* Doubtless the above names may be added to the list of synonyms of the conidial forms of *Glomerella cingulata* (Stonem.) Sp. & v. Schrenk given by Shear and Wood in Bull. 252, Bureau of Plant Industry, 1913.

Septogloeum Celtidis sp. nov.

Spots angular, 1–3 mm., becoming extensively confluent, dull-brown beneath, gray-brown on the upper side. Acervuli innate, hypophyllous, orange in the center, surrounded by a raised rim of the leaf tissue, numerous on the spot mostly about 250 μ. Sporules hyaline, straight or flexuous or most frequently more or less strongly curved, continuous or 1- to 3-septate, 15–33 x 3–3.5 μ.

On leaves of *Celtis occidentalis* L. Orient, N. Y.; Oct., 1919. Roy Latham: *83*.

Rhopalidium cercosporelloides sp. nov.

Spots indefinite, the affected parts of the leaf turn reddish-brown on the upper side and tawny beneath, paler when held to the light than the surrounding tissue. The acervuli discharge yellowish masses of spores chiefly on the upper side which when acted upon by moisture become white flakes, .5–1 mm., suggesting *Cercosporella*. Sporules hyaline, straight, elongated-clavate, one portion grumous-guttate, 1- to 2-septate, 4–6 μ thick, 30–40 μ long, the remaining portion variously prolonged and attenuated even to 100 x .5 μ. Conidiophores 10–50 x 1–1.5 μ.

On living leaves of *Spiraea Menziesii* or *corymbosa*. Priest River Expt. Sta., Bonner Co., Idaho; Sept. 22, 1922. J. S. Boyce: *1040*.

Scolecosporium pedicellatum Dearn. & Overh., sp. nov.

Acervuli erumpent to cupulate, black, thickly scattered, .5–.75 mm. Conidia sub-elliptic, mostly inequilateral owing to slight curvature, 4 brown cells and 2 hyaline end cells, the distal cell a short, somewhat oblique, conic beak, 3–6 μ long, the proximal one similar, usually longer, the brown portion 18–25 x 7.5–10 μ, obliquely adnate to hyaline, simple or branched conidiophores, 38–75 x 2 μ.

On bark of living apple tree injured by cicadas, Mont Alto, Pa.; March, 1923; C. R. Orton. L. O. Overholts: *8657*.

TOXOSPORIUM CAMPTOSPERMUM (Peck) Lind

?Pestalozzia camptosperma Peck. 1886

Coryneum bicorne Rostr. 1899

Parasitic on leaves of *Abies grandis* Lindl. Multnomah Co., Oreg. J. S. Boyce: *1140*.

Coryneum cinereum sp. nov.

Acervuli amphigenous, appearing as small grayish stains, .5–1 mm., tardily raising and rupturing the cuticle. Conidia brown, oblong, sometimes wider above, uniformly 4-celled, 21–24 x 6–9 μ, wall 1.5 μ thick, on hyaline conidiophores, 15–40 μ long.

Parasitic on the older needles of *Pinus contorta* Dougl. Deschutes National Forest, Klamath Co., Oreg.; Sept., 1921. J. S. Boyce: *828*. On *Pinus Murrayana* Balf.; Tolland, Colo., Aug., 1910; Prof. Bethel.

Coryneum thujinum sp. nov.

Acervuli hypophyllous, black, scattered, emergent, the ruptured cuticle being raised like a lid on one side, .3–.5 mm. in length. Conidia brown, somewhat curved, the upper third bent inward at a wide angle, 7- to 10-septate, end cells pale, 40–50 μ, mostly about 45 x 6–8 μ on conidiophores of about half their length.

On dead leaves of *Thuja plicata* Don. Cascade National Forest, Lane Co., Oreg.; alt. 12,000 ft.; Oct. 22, 1921. J. S. Boyce: *831*. Also at McCredie's Hot Springs, Oreg. "This species is parasitic."—J. S. B.

Hyaloceras Hamamelidis sp. nov.

Acervuli thickly scattered, cortical, rupturing the epidermis, circular, 70–200 μ or irregularly elongate up to 1 mm. Conidia brown, 5-septate, 18–26 μ, mostly about 24 x 9–11 μ with a hyaline boss at each end terminated by a curved hyaline cilium 6–11 μ.

On dead trunks of *Hamamelis virginiana* L. Near London, Ont., May, 1912. Dearness: *3971*.

Cylindrosporium brevispina sp. nov.

Spots amphigenous, 1–4 mm., reddish, turning brown, paler beneath, angular becoming confluent especially along the edges of the leaves. Acervuli hyophyllous, numerous, large, 80–220 μ, finally becoming marked depressions or cavities in the leaf-tissue. Sporules 30–90 μ, mostly about 45–50 x 3–4 μ, grumous-guttate, subclavate, continuous to 3-septate.

On living leaves of *Crataegus Douglasii* Lindl. (*brevispina* Dougl.). Sidney, B. C.; Sept., 1914; John Macoun: *47*. Missoula Mont., 1917; J. R. Weir; *9034*. Trinity Forest, Cal.; June, 1914; J. S. Boyce: *793*.

This fungus was treated as a var. of *C. Crataegi* E. & E., Mycologia 8: 105. Subsequent comparison with the type and study of additional collections warrant the raising of the variety to a species.

Cylindrosporium consociatum sp. nov.

Spots angular, usually limited by veinlets and often partly or wholly surrounded by a narrow pallid rim, reddish-brown above, beneath duller in color and usually made gray by the numerous pycnidia of *Phyllosticta minutissima* E. & E., 2–8 x 2–4 mm. Acervuli epiphyllous, scattered, often indicated by cirrhi or flakes of exuded spores, 80–100 μ in diameter or confluent along a vein or often irregular depressions overlying a vein. Sporules hyaline, straight, flexuous or curved, 1- to 4-septate, 35–60 x 2–2.25 μ, exceptionally 75–80 μ long.

On living leaves of *Acer glabrum* pretty constantly associated with a minute *Phyllosticta,* hence the specific name. Priest River, Idaho, Sept., 1922; J. S. Boyce: *1034, 1035, 1175.* Two collections at Vernon, B. C. Also at Newport, Wash. A. S. Rhoads (J. R. Weir: *16,894*). Exsiccati: F. Col. *1244, 2251* labelled *Phyllosticta minutissima* E. & E.

Phleospora curvispora (E. & E.) Petrak—see note under *Septoria circinata* E. & E.—was based on part of the Newport collection. The fungus on other leaves of this collection received from Dr. Weir do not seem to be separable from *C. consociatum.* The irregular acervuli and most of the others examined do not seem to possess what might be called a pycnidial wall.

CYLINDROSPORIUM NUTTALLII (Hark.) comb. nov.

Syn.: *Septogloeum Nuttallii* Hark. Calif. Acad. Sci., Feb., 1884, p. 13.

Cylindrosporium conservans Peck, N. Y. Mus. Bull. 150: 53. 1910.

Exsiccati: F. Col. *3315, 4414.*

Since the publication of the note on *Septogloeum Nuttallii* in Mycologia 9: 357, I have examined co-types of the latter and *Cylindrosporium conservans* erroneously published on *Salix,* and find them the same species. Both co-types are on *Osmaronia cerasiformis* (T. & G.). Good collections were made at Lake Chelan by

J. R. Weir and at Rainier by J. S. Boyce on *Osmaronia*. Mr. Boyce found it also on *Prunus demissa* in MacLeay Park, Portland, Oreg.

Cylindrosporium Urticae sp. nov.

Spots numerous, scattered, small, about 2 mm. unless confluent, quadrate, not bordered, translucent. Acervuli 85–100 μ, several on each spot, watery-looking depressions, visible from either side of the leaf. Conidia filiform, continuous, flexuous, 33–45 x 2–2.25 μ.

On living leaves of *Urtica Lyallii* S. Wats. Langley, Wash.; Sept., 1923. J. M. Grant: *6746*.

HYPHOMYCETES

BOTRYTIS RILEYI Farl.

Rept. U. S. Commissioner of Agriculture, 1883, p. 121

On the clover looper—*Plathypena scabra*—Orient, N. Y., Sept., 1922. Roy Latham: *572*. Determination confirmed by Dr. Roland Thaxter. "This fungus killed thousands of larvae on beans this season (1922)."—R. L.

Coniosporium subcorticale Dearn. & Barth., sp. nov.

Under the loosened bark in small cumuli or crowded or scattered along lines between the fibers of the cortex and particularly around and upon the stromata of a *Diaporthe*. Spores brown, sub-globose, 6–9 x 5.5–7 μ.

On dead branches of *Celastrus scandens* L. bearing *Diaporthe celastrina* Dearn. & Barth. Madison, Wisc.; Aug. 26, 1919. E. Bartholomew: *6651*a.

Trichosporium Falcatae Dearn. & Barth., sp. nov.

Mostly hypophyllous imparting to the lower side of the leaf a sooty-brown coating and darkening the upper surface of the affected parts. Main lines of hyphae up to 9 μ in thickness spread over the surface, climb up the trichomes and gives off fertile branches 15–40 x 3.5–4 μ upon the distal third or more of which conidia are crowded. Conidia pale-brown, continuous, narrowly elliptic, somewhat catenate, slightly narrower at the lower end, often nucleate, 7–11 μ, mostly 8–9 x 3–3.5 μ.

Parasitic on living leaves of *Falcata Pitcheri* (T. & G.) Kuntze. Longview, Texas; Oct. 1, 1921. E. Bartholomew: *7536*.

Trichosporium pinicolum Dearn. & Barth., sp. nov.

Hyphae smoky-hyaline, branching, 1.5–3 μ thick, obscured by the black masses of conidia, 2–4 mm. across. Conidia black, sessile, lenticular, 15–18 μ long, 10–15 μ broad, 8–12 μ thick.

On bark of fallen limbs of *Pinus monticola* Dougl. Placeville, Idaho; Aug. 21, 1917. L. M. Benbow. J. R. Weir: *9071.*

(?) **Cladosporium Salicis-sitchensis** Dearn. & Barth., sp. nov.

Spots on the upper side of the leaf dark-brown, angular, irregular, 2–10 mm., surrounded in the early stages by diffuse, indefinite, pale-red areas of variable width; on the lower side of the leaf they show as sooty areas in the dense pubescence. Hyphae hypophyllous, brownish, sparingly branched, .2–1 mm. long by 3–5 μ thick. Conidia smoky-hyaline, solitary or shortly catenate, oblong-elliptic, 8–28 x 5–10 μ, average about 15–5.5 μ.

Producing conspicuous discolorations on living leaves of *Salix sitchensis* Sanson. Olympia, Wash.; Sept., 1912. E. Bartholomew: *4933.* Langley, Wash.; Nov., 1922. J. M. Grant: *5011.*

Helminthosporium stromatoideum sp. nov.

On tubercular or stroma-like bases scattered over the branches, .2–.4 mm. in diameter. Conidia in well-developed examples thickly congregated over the base, 8- to 20-septate, widest in the middle where they reach 12 μ and gradually reduced to 6–8 μ at each end, 100–160 μ long, the median septa about 12 μ apart.

On dead branches of *Tsuga canadensis* (L.) Carr. Hudson Falls, N. Y.; Feb., 1915. S. H. Burnham: *22.*

Stigmella Nemopanthis sp. nov.

Fertile hyphae hyaline, very short, 6–15 x 4–5 μ, septate. Aggregations resembling blackberries under the low power break up by the slightest movement of the cover-glass into separate, dark-brown, sub-circinately muriform conidia, 20–35 x 20–25 μ, the cells mostly 4–6 μ wide, suggesting under the high power a minute, compacted *Helicoma.*

Appearing as a sooty sprinkling on the bark of dead branches of *Nemopanthes mucronata* (L.) Trel.; June, 1915. Dearness: *3825.*

Cercospora Ichthyomethiae Dearn. & Barth., sp. nov.

Spots begin as small gray, circular discs, 2–5 mm. in diameter, extending in areas between the veins of the leaf; the original circular spots persist as pale discs in the large, dark-drab areas, all marked by a distinct reddish-brown border, .5 mm. wide; the colors similar but duller on the lower side of the leaf. Fascicles of short, sparingly branched, brown, fertile hyphae, 5–30 x 3–4 μ arise chiefly but not solely on the upper side of the leaf from dark-brown tubercles mostly 50–80 μ in diameter. Conidia brown, obclavate, 1- to 4-septate, 15–60 μ, mostly 25–45 x 3–4 μ in the widest part reducing to 1.5 μ at the tip. An immature *Sphaeria*, probably related, among the tubercles.

On living leaves of *Ichthyomethia piscipula* (L.) A. Hitchc. Miami, Fla.; March, 1923; L. W. Nuttall.

Dendrostilbe Ulmi sp. nov.

Stipes brown, erumpent, single or in small clusters, 1 mm. high, .25 mm. thick, surmounted by a yellow sub-globose capitulum bearing branched conidiophores, branches 15–40 x 1 μ. Conidia hyaline, oblong, 4–6 x 2.5 μ.

On dead limbs of *Ulmus americana* L. Hudson Falls, N. Y.; June, 1916. S. H. Burnham: *127*.

Atractilina Dearn. & Barth., gen. nov.

Fertile hyphae collected into a stalk bearing at the summit elongated, spindle-shaped, septate, hyaline conidia, singly and in chains.

Between *Atractium* and *Symphyosira* in *Stilbaceae*.

Atractilina Callicarpae Dearn. & Barth., sp. nov.

Spots reddish, indefinite, rust-like, scattered, numerous, 2–4 mm. Synnema gregarious on the spots, fibrous, .5–.75 mm. in height and 50–75 μ in thickness, conspicuously tufted or brush-like in the upper fourth of their length. Conidia weakly catenate or single, spindle-shaped, hyaline or dilutely colored, continuous or 1- to 4-septate, mostly 3-septate, the main portion 25–30 x 5–7 μ, gradually contracting into a narrow stipe-like part 12–15 μ long.

On *Callicarpa americana* L. Miami, Fla.; March 15, 1923; L. W. Nuttall.

Tuberculina flavogranulata Dearn. & Barth., sp. nov.

Spores hyaline, broadly elliptic, 6–9 x 5–6 μ, borne acrogenously on fasciculate hyphae, 3–4 μ in diameter. Many of the latter are modified distally into sub-clavicular, spore-like portions, 10–12 x 3 μ. The yellowish sporodochia with hyphae and spores vary in size from mere globose specks to irregular masses nearly 1 mm. in diameter giving the lower side of the leaf the appearance of having been sprinkled with cornmeal.

Parasitic on *Uromyces Hedysari-paniculata* (Schw.) Farl. on living leaves of *Meibomia paniculata* (L.) Kze. Spiro, Okla.; Oct. 12, 1921. E. Bartholomew: *7623*.

LONDON, ONTARIO.

THE MICROTHYRIACEAE OF PORTO RICO

Ruth W. Ryan

The Microthyriaceae of Porto Rico are numerous and constitute an interesting part of the fungus flora, though heretofore little or no study has been made of them. They are in distribution practically like *Meliola: i.e.,* limited to native plants and to the higher and wetter altitudes, and appear therefore to be historically of similar relation. So little is known of the Microthyriaceae that no generalizations are yet possible regarding the origin of this group. The forms of Porto Rico in general show less diversity than those of Hawaii, most of them belonging to such well known genera as *Asterina* and *Morenoella.*

Some of the species agree sufficiently with printed diagnoses to warrant the assumption that they are co-specific with previously described forms, while others must be regarded as new species or even as belonging to new genera.

The taxonomy of this group as based on the morphology of the forms previously known is summarized in two extensive articles, one by Theissen and Sydow (1), and the other by G. Arnaud (2).

The system of Theissen, based as it is so largely on spore septation and color, is distinctly artificial in character, while that of Arnaud is based on more fundamental morphological characters, though lacking, of necessity, in ease of application. The pertinent portion of Theissen's key is reproduced.

The material used in this study consisted of specimens collected by Dr. F. L. Stevens in Porto Rico during the years 1913, 1914, and 1915.

1. **Theissen, F., Sydow, H.** Synoptische Tafeln. Ann. Myc. 15: 413. 1917.
2. **Arnaud, G.** Les Asterinées, Annales de l'Ecole Nationale d'Agriculture.

Key to the Genera of Porto Rican Microthyriaceae. Adapted from Theissen

Free mycelium absent..... Microthyrieae.
Perithecia round.
Spores 2-celled, brown.

Perithecia single.....1. *Seynesia* Sacc. 7.
Spores 2-celled, hyaline.....2. *Microthyrium* Desm. 4.
Free mycelium present..... Asterineae.
Perithecia round.
Spores hyaline, 2-celled.
Hyphopodiate.
Perithecia not setose.....3. *Caudella* Syd. 3.
Non-hyphopodiate .....4. *Calothyrium* Th. 4.
Spores 2-celled, brown.
Hyphopodiate.
Paraphysate .....5. *Asterina* Lév. 5.
Aparaphysate .....6. *Englerulaster* v. Höhn. 6.
Non-hypopodiate .....7. *Asterinella* Th. 1.
Perithecia linear.
Asci 8-spored, 2-celled.
Spores hyaline, aparaphysate...8. *Aulographum* Lib. 12.
Spores brown.
Hyphopodiate.
Paraphysate .....9. *Lembosia* Lév. 8.
Aparaphysate .....10. *Morenoella* Speg. 9.
Non-hyphopodiate.
Paraphysate .....11. *Echidnodes* Th. and Syd. 10.
Aparaphysate .....12. *Echidnodella* Th. and Syd. 11.

1. SEYNESIA Sacc. Syll. Fung. 2: 668

Seynesia coccolobae n. sp.

Perithecia round, radiate, carbonaceous, 672–1200 μ in diameter, hypophyllous, scattered, few colonies 1–1.5 mm. in diameter. Margin irregular, but not fimbriate, free mycelium lacking. Asci spatulate, 19–21 x 84–96 μ, paraphyses hyaline, filiform, equal in length to the asci, tips globular. Spores hyaline becoming dark, 7–9 x 19 μ, 2-celled.

On *Coccoloba laurifolia.* No. 7611; Arecibo and Lares road, no. 7292; Maricao, no. 813.

Seynesia cordiae n. sp.

Perithecia is poorly invert radiate, superficial, 150–240 μ in diameter, some are nearly linear, margin irregular. Internal mycelium hyaline. Paraphyses filiform, often indistinct. Asci 17 x 34 μ, spatulate to oval; spores 2-celled, brown when mature, 3.5 x 10 μ. Fungus on the lower surface of the leaf, completely covering it.

On *Cordia sulcata.* College grounds, Mayaguez, no. 975.

2. MICROTHYRIUM Desm. Ann. Sc. Nat. **15**: 138. 1841

Microthyrium calophylli n. sp.

Perithecia round, carbonaceous, 224–336 μ in diameter. Free mycelium lacking. Asci 9.6 x 62 μ, clavate. Paraphyses filiform, numerous, as long as the asci. Spores hyaline, 2-celled, slipper shaped, the superior cell broader and longer, 5 x 14 μ.

On *Calophyllum* sp. Maricao, no. 881.

3. CAUDELLA Syd. Ann. Myc. **14**: 90. 1916

Caudella psidii n. sp.

Perithecia round, ostiolate, carbonaceous, margin fimbriate, 280–391 μ in diameter. Mycelium brown, 5 μ thick, septate, much branched, anastomosed or fasciculated, non-hyphopodiate. Asci 96–120 x 19–24 μ, spatulate, paraphysate. Spores 2-celled, the inferior gradually tapering into a stalk, 12–14 x 36–48 μ, the superior cell 12–14 x 19 μ, the inferior cell 9 x 24 μ, hyaline. The fungus forms gregarious spots on the leaf 3–5 mm. in diameter, discoloring the leaf.

On *Psidium guajava*. Rio Tanamá, no. 7834; Mayaguez, no. 3899; Las Marias, nos. 8128, 2899; Dos Bocas, below Utuado, no. 6562; San Sebastion, no. 5202.

4. CALOTHYRIUM Th. Ann. Myc. **10**: 160. 1912

Calothyrium psychotriae n. sp.

Perithecia 112 μ in diameter, round, carbonaceous. Mycelium grey-brown, 5 μ thick, crenulate. Asci nearly round, 12 μ in diameter, embedded. Spores 2-celled, hyaline, 2 x 5 μ.

On *Psychotria* sp. Preston's ranch, no. 6662 (type).

Calothyrium hippocrateae n. sp.

Perithecia round to slightly oval, 84–96 μ in diameter; distinctly radiate throughout, vertically dehiscent, smoky brown. Mycelium superficial septate, greatly branched, non-hyphopodiate, 2 μ thick, light brown. Asci ovate with thickened apex, 14 x 17–19 μ. Spores 2 x 12 μ, equal celled, hyaline.

On *Hippocratea volubilis*. No data.

Calothyrium ingae n. sp.

Perithecia 108 μ in diameter, round, light brown, distinctly radiate. Mycelium light brown, 3 μ thick, non-hyphopodiate. Asci

round to ovate, 14 x 17 or 14 μ in diameter, aparaphysate. Spores hyaline, 2-celled, 2 x 12 μ. The fungus is found on the lower surface of the leaves.

On *Inga vera.* No data.

5. ASTERINA Lév. Ann. Sc. Nat. III, **3**: 54. 1845

Asterina genipae n. sp.

Perithecia round, distinctly radiate, black-brown, 192 μ in diameter, edge irregular. Mycelium light brown, 5 μ thick, much branched. Hyphopodia alternate, sessile, 5–7 x 5 μ. Asci oval, 41 x 58 μ, embedded in tissue, aparaphysate, 8-spored. Spores brown, 14–16 x 29–36 μ.

On *Genipa americana.* Mayaguez, no. 1861 (type).

Asterina drypetis n. sp.

Perithecia gregarious, forming spots .5–2.5 cm. Perithecia round, carbonaceous, radiate, ostiolate, margin irregular, 127–426 μ in diameter. Mycelium dark brown, 9 μ thick. Hyphopodia lobed, straight to slightly beaked, 10 x 22 μ, 1-celled. Asci embedded, 29–36 x 38–43 μ. Spores 2-celled, heavy walled, 10–12 x 28–31 μ.

On *Drypetes* sp. Rio Tanamá, no. 7481 (type).

Near *Asterina dispar,* but differs from it in having regularly septate spores, larger perithecia and mycelium, and smaller asci and spores.

ASTERINA INAEQUALIS var. NODULOSA Speg. F. Puig. no. 353.

On *Rubiaceae.* Monte de Ora, no. 5668a; on *Hirtella triandra.* Arecibo-Lares road, no. 7303.

ASTERINA VAGANS Speg. F. Guar. 2, no. 127.

On *Tournefortia laurifolia.* Mayaguez, no. 7079. The fungus agrees with the description given in the above citation.

Asterina fawcetti n. sp.

Perithecia 190–264 μ in diameter, carbonaceous, ostiolate, mycelial hyphae of perithecia closely united, margin wavy. Mycelium brown, 5 μ thick. Hyphopodia sessile, alternate, hemispherical, 1-celled, 5 x 7 μ. Asci ovate, aparaphysate, 24–48 x 51–65 μ. Spores 2-celled, 9–12 x 29–31 μ, brown when mature, heavy walled and equal celled.

On *Eugenia buxifolia.* Vega Baja, no. 7713 (type); on *Eugenia* sp. Mona Island, nos. 6151, 6160, 6163, 6155.

Near *Asterina chrysophylli.* The hyphopodia and asci are smaller and the spores are narrower.

Named in honor of G. L. Fawcett, because of his work on the Porto Rican fungi.

Asterina sidicola n. sp.

Perithecia black, radiating, edge incised, 123–156 μ in diameter. Mycelium brown, tortuous, 5 μ thick. Hyphopodia alternate, sessile, lobed, 7 μ long. Asci elliptical to ovate, 10–12 x 31–33 μ, aparaphysate, 8-spored. Spores 2-celled, rough walled, brown, 5 x 12–14 μ.

On *Malvaceae.* Jajome Alto, no. 5693 (type); on *Sida* sp. Rosario, no. 4809; on *Malvaceae.* No. 6663a; on *Sida carpinifolia.* Maricao, no. 8869; Vega Baja, no. 401; on *Corchorus hirtus.* Rio Tanamá, no. 7877; on *Abutilon* sp. Jajome Alto, no. 5642.

Asterina hippocrateae n. sp.

Perithecia 96–104 μ in diameter, radiate, round, dark-brown. Mycelium brown, septate, much branched, 7 μ thick. Hyphopodia alternate, sessile, 12 x 14–19 μ, with a hyaline central spot. Asci ovate, 26–38 x 36–45 μ, aparaphysate. Spores brown, 2-celled, heavy walled, smooth, elliptical, each cell containing a hyaline vacuole, spores 14 x 31 μ.

On *Hippocratea volubilis.* Martin Pena, no. 9296 (type). Also on the same host collected at Vega Baja, nos. 7726, 9296a.

Asterina miconiae n. sp.

Perithecia black, margin irregular, 168–201 μ in diameter. Mycelium dark, 7 μ thick. Hyphopodia sessile, alternate, slightly wavy, 5 x 9 μ. Asci spatulate, aparaphysate, 9 x 41–48 μ. Spores brown, 2-celled, 5–7 x 19–24 μ.

On *Miconia racemosa.* Las Marias, no. 8136 (type); Mayaguez, no. 7417; Trujillo Alto, nos. 9424, 7417a. On *Miconia thomasiana.* Sabana Grande, no. 9373.

ASTERINA DILABENS Syd. Ann. Myc. 2: 168. 1904.

On *Tetrazygia elaeagnoides.* Cascinole, no. 9242; on *Solanum rugosum.* El Alto de la Bandera, no. 8661; on *Gesneria* sp. Rio

Tanamá, no. 7907; on *Rhytidophyllum auriculatum.* Rio Tanamá, no. 8105.

Asterina ixonae n. sp.

Perithecia 168–180 μ in diameter, showing two distinct regions, the inner black, carbonaceous, the outer radiate with a very irregular margin. Asci elliptical, aparaphysate, 12 x 55 μ. Spores light brown, 2-celled, 3–5 x 12–14 μ. Mycelium brown, septate, 2 μ thick. Hyphopodia brown, sessile, subcylindrical, sparse, 5 x 9 μ long.

On *Ixona ferrea.* Mayaguez, no. 7070 (type). This species resembles *Asterina aspidii,* but is larger.

Asterina racemosae n. sp.

Perithecia 100–216 μ in diameter, ostiolate, grey-black, margin regular, carbonaceous. Mycelium septate, smoky, 5 μ thick. Hyphopodia sessile, alternate, 7 x 9 μ. Spores 2–3 x 12–17 μ, the inferior cell slightly longer than the superior.

On *Miconia racemosa.* Jajome Alto, no. 8402 (type); Mayaguez, no. 7037; Las Piedras, nos. 9321, 9322; Trujillo Alto, no. 9425; on *Miconia sintenisii.* Rio Maricao above Maricao, nos. 3646, 3887; Las Marias, no. 312; on *Miconia impetiolarus.* Rio Piedras, no. 5701.

Asterina miconicola n. sp.

Perithecia 144–288 μ, black, carbonaceous, gregarious. Mycelium abundant, much branched, 5 μ thick, septate, grey-brown. Hyphopodia sessile, alternate, 9 x 7 μ. Spores 2–3 x 12–17 μ, the inferior cell slightly longer than the superior.

On *Miconia racemosa.* Maricao, no. 8940 (type); Bandera, no. 8292; on *Palicouria.* Jajome Alto, no. 5683a.

Asterina guianensis n. sp.

Perithecia radiate, distinctly ostiolate, green-brown, 96–144 μ in diameter. Free mycelium present, 7 μ thick, septate, green-brown. Hyphopodia sessile, 1-celled, hemispherical, 7 x 9 μ. Asci obovate, 28 x 48 μ, aparaphysate. Spores dark brown, 2-celled, cylindrical, tapering at the ends, 12–14 x 24–38 μ.

On *Miconia guianensis.* El Alto de la Bandera, no. 8250. This species resembles *A. camelliae* but is smaller.

ASTERINA CAMELLIAE Syd. and Butl. Ann. Myc. **9**: 389. 1911.

On *Miconia splendens*. El Alto de la Bandera, no. 8653. On unknown host. Jajome Alto, no. 8401.

ASTERINA CHRYSOPHYLLI Henn. Hed. **48**: 12. 1908.

On *Miconia laevigata*. Las Piedras, no. 2366 (type); on *Chrysophyllum* sp. San German, no. 4495; Vega Baja, no. 7608; on *Melastomaceae*. Lajas, no. 7145. The fungus examined on *Miconia laevigata* resembles the description given by Hennings.

Asterina tetrazygiae n. sp.

Perithecia round, carbonaceous, margin irregular, ostiolate, 168–280 μ in diameter. Mycelium 7 μ thick, dark brown, branches opposite. Hyphopodia irregular, alternate, not distinctly lobed, 7–9 x 14 μ. Asci ovate to elliptical, 48–50 x 60–65 μ, aparaphysate. Spores brown, 2-celled, 17–19 x 31–36 μ.

On *Tetrazygia* sp. Jajome Alto, nos. 8430, 8940; on *Tetrazygia elaeagnoides*. Rio Arecibo, no. 7778 (type). The fungus is larger than *A. megalospora*.

Asterina passifloricola n. sp.

Perithecia gregarious, forming spots, 1–3 mm. in diameter, round to cylindrical, 123 μ in diameter, or 96–157 x 120–203 μ. Mycelium light brown, branches few, 3–5 μ thick. Hyphopodia knob-like, 9 μ long, alternate, abundant. Asci numerous, 24–31 x 36–41 μ. Spores hyaline, becoming dark brown, ovate, 2-celled, heavy walled, the superior cell more rounded, 9–12 x 21 μ.

On *Passiflora rubra*. Dos Bocas, no. 8039; Monte de Ora, no. 5561. This fungus differs in its hyphopodia from *Asterina megalospora*.

ASTERINA TACSONIA Pat. Bull. Soc. Mycol. Fr. page 147. 1893.
var. **passifloræ** n. var.

Perithecia 132–156 μ in diameter, opening by a radiate fissure from the center to the outer margin, hypophyllous. Mycelium light brown, 5 μ thick, sparsely branched. Hyphopodia alternate, lobed, 7–9 μ long, sometimes knobbed. Asci 24 x 29–32 μ. Spores hyaline, 5–7 x 14–19 μ. Conidia spores brown, 1-celled, having a hyaline band through the center, 6–7 x 12–17 μ.

On *Passiflora* sp. Dos Bocas below Utuado, no. 6575. On *Passiflora sexflora.* El Miradero, no. 9165; Dos Bocas, no. 8040. On unknown host, Rio Maricao above Maricao, no. 3654.

This fungus agrees in many details with *Asterina tacsonia.* However, the spores and asci found were smaller. No brown 2-celled spores were seen, nor was the brown membrane. This, however, may be due to the fact that the asci were immature. Further investigation may necessitate classifying it as a hyaline, 2-celled spored genus, thereby creating a new genus, which will be put in the key near *Claudella,* differing from it by having no appendages on the spores. It differs from *A. passifloricola* by being smaller and having lobed hyphopodia.

ASTERINA SOLANICOLA B. & C., Cuban Fungi no. 738. 1868.

On *Cestrum laurifolium.* Common throughout the island. On *Cestrum macrophyllum.* Monte Alegrillo, no. 7709a; on *Pavonia spinifex.* Vega Baja, no. 9265; on *Clusia gundlachii.* El Alto de la Bandera, no. 8690.

Asterina arnaudia n. sp.

Perithecia round, margin fimbriate, 132–156 μ in diameter, opening by a radial fissure from the center to the edge. The whole perithecium distinctly radiate. Mycelium 5 μ thick, dark brown, heavy walled, greatly branched. Hyphopodia knobbed, alternate, 9–12 μ. Asci 38–41 x 43–60 μ, aparaphysate, subglobose. Spores dark brown, echinulate, 2-celled, 9–12 x 26–34 μ.

On *Passiflora multiflora.* Rio Tanamá, no. 7945 (type), 7943; Catano, no. 4192; on *Passiflora sexflora.* El Alto de la Bandera, nos. 8642, 8284; Rio Arecibo, no. 7784. Named in honor of G. Arnaud for his work on the Asterineae. Asci and spores are larger than *A. passifloricola,* while spores are brown and the hyphopodia are not lobed as in *A. tacsonia.*

Asterina sydowiana n. sp.

Perithecia carbonaceous, edge entire, round, 112–224 μ in diameter. Mycelium dark brown, 2 μ thick. Hyphopodia alternate, hemispherical, sessile, 2 x 7 μ. Asci 19–31 x 36–38 μ, oval to nearly spherical. Spores hyaline, later becoming dark brown, 2-celled, granular in appearance, 9 x 21 μ.

On *Chrysophyllum* sp. Monte Alegrillo, no. 4731. Named in honor of H. Sydow for his work on the family Microthyriaceae.

Asterina psidii n. sp.

Perithecia gregarious, amphigenous, round, 228 μ in diameter, or oval, 190–302 μ, margin slightly fimbriate. Mycelium septate, brown, irregularly branched, 5–7 μ thick. Hyphopodia club shaped, 5 x 10–12 μ. Asci aparaphysate, ovate to elliptical, 33–38 x 60–65 μ. Spores when mature brown, 2-celled, 12–17 x 26–33 μ.

On *Psidium guajava.* Mayaguez, no. 310. This fungus resembles *A. carbonaceae,* but has larger perithecia and spores.

ASTERINA TRANSIENS Th. Abhand. des k. k. zoo.-bot. Ges. in Wien, vol. 7, part 3.

On *Melastomaceae.* Maricao, no. 4803a; Monte de Ora, no. 5747; Jajome Alto, no. 5652.

ASTERINA CORREACOLA Cke. and Mass. Grev. **16:** 5. 1887.

On *Melastomaceae.* Manati, no. 5249; on unknown host.

Asterina portoricensis n. sp.

Perithecia black, distinctly radiate throughout the entire perithecial covering, 72–84 μ in diameter, round, margin regular. Mycelium branching profusely, 5 μ thick. Hyphopodia alternate, cylindrical, sessile, 5 x 9–7 μ, alternate. Asci ovate, 19–21 x 19–29 μ. Spores dark, 2-celled, 9 x 17–19 μ.

On *Solanum* sp. Quebradillas, no. 5127 (type).

Asterina psychotriae n. sp.

Perithecia 84–201 x 94–240 μ, margin regular, carbonaceous. Mycelium dark brown, 5 μ thick, branches alternate. Hyphopodia sessile, 5 x 7–9 μ, alternate. Asci spatulate to ovate, 24 x 48 μ. Spores dark, 2-celled, granular, with a hyaline spot in each cell, heavy walled, equal celled, ovate, 7–12 x 14–19 μ.

On *Psychotria pubescens.* Mayaguez, no. 7581 (type).

ASTERINA ELAEOCARPI Syd. Abhand. der k. k. zoo.-bot. Ges. in Wien, vol. 7, part 3, page 73.

On *Cassia alata.* Mayaguez, no. 3913.

Specimens studied agreed with the description given by Sydow.

ASTERINA SCHROETERI (Rehm) Th. Hedw. **37:** 326. 1898.

On *Chrysobalanus* sp. Guanajibo, no. 7230; on *Chrysobalanus icaco*. Mayaguez, no. 7413; Las Piedras, no. 9323; Manati, nos. 5247, 5281; Trujillo Alto, no. 9426; on *Chrysobalanus pellocarpa*. San José Laguna, no. 9208; on *Chrysobalanus icaco*. Mayaguez, no. 7431.

ASTERINA DIPLOCARPA Cooke, Grev. **10:** 129. 1882.

On *Croton discolor*. Guayanilla, no. 8540. The specimens examined had slightly larger perithecia, asci, and spores than *A. diplocarpa*, but the differences were not great enough to necessitate a new species.

ASTERINA PUNCTIFORMIS Lév. Ann. Sc. Nat. **5:** 267. 1846.

On *Gesneria* sp. no. 7464. No data.

Asterina myrciae n. sp.

Perithecia 108–116 μ in diameter, ostiolate, margin regular, carbonaceous. Mycelium 5 μ thick, branched, olive brown. Hyphopodia 2-celled, 12 x 21 μ, chiefly occurring in the axils of the branches, the superior cells smaller. Asci oval, 12–19 x 21–24 μ, or round, 17 μ in diameter. Spores olive brown, 2-celled, 7 x 19 μ, one side of the spore curved while the other is straight.

On *Eugenia* sp. Rosario, no. 9494 (type); on *Myrcia splendens*. Maricao, no. 8831; Mayaguez Mesa, nos. 7575, 7473.

ASTERINA CARBONACEA Speg. F. Guar. part 2, p. 47, no. 128.

var. **anacardii** n. var.

Perithecia 280–392 μ in diameter, round, carbonaceous, margin regular, fissure radiate, perithecia gregarious, 5 mm. in diameter. Mycelium 5 μ thick, dark brown, abundant. Hyphopodia 5 x 7 μ, cylindrical, sessile, alternate, numerous. Spores light brown, 2-celled, 31–36 x 12–14 μ. Each cell has two hyaline spots.

On *Anacardium excelsum*. Indiera Fria, Maricao, no. 3369. On *Melastomaceae*. Monte de Ora, no. 5745; Lugiullo Forest, nos. 5595, 544.

Asterina melastomacearum n. sp.

Perithecia 168–268 μ in diameter, round, black, margin fimbriate. Mycelium 7 μ thick. Hyphopodia alternate, sessile, slightly

wavy, 7 x 12 μ. Asci ovate, aparaphysate, 43 x 53–62 μ. Spores dark brown, 2-celled, 14 x 26 μ.

On *Miconia racemosa.* No. 7037. On *Miconia impetiolaris.* Jayaya, no. 375.

ASTERINA DIPLOCARPA Cooke, Grev. **10:** 129. 1882.

var. **cestricola** n. var.

Perithecia round to slightly oval, 132–168 μ in diameter, radiately dehiscent, often forming spots 4–8 mm. in diameter on the surface of the leaf. Mycelium grey-black, 2 μ thick, much branched. Hyphopodia alternate, lobed, sessile, 7 x 9 μ. Asci round to ovate, 31 x 36 μ, or 24 μ in diameter, aparaphysate. Spores dark brown, verrucose when mature, 7 x 19 μ, the inferior cell larger.

On *Cestrum* sp. Ejome Alto, nos. 8397, 8384; Arbonito, no. 8463; on *Cestrum macrophyllum.* No data.

The perithecia and spores are smaller than those of *A. diplocarpa.* The mycelium is also thinner and the hyphopodia are lobed.

Asterina theissenia n. sp.

Fungus gregarious, spots 5 mm. in diameter, often covering the entire upper surface of the leaf. Perithecia 168–265 μ in diameter. Top of the perithecium easily breaks away. Mycelium crenulate, 2 μ thick, dark brown. Hyphopodia alternate, cylindrical to hemispherical, 5 x 7 μ. Asci embedded, round to ovate, 24 μ in diameter, to 24 x 38 μ, aparaphysate. Spores brown, 2-celled, superior cell broader, 9 x 19 μ.

On *Melastomaceae.* Las Marias, no. 451; on *Miconia* sp. Las Marias, no. 759a.

Named in honor of F. Theissen for his great work on the Microthyriaceae.

ASTERINA DILABENS Syd. Ann. Myc. **2:** 168. 1904.

var. **hilliae** n. var.

Perithecia round to oval, ostiolate, 168–201 μ in diameter, to 414 x 280 μ, carbonaceous, margin fimbriate. Mycelium abundant, 7 μ thick. Hyphopodia sessile, lobed, 7 x 12 μ, alternate. Asci 21–26 x 36–60 μ, ovate, aparaphysate. Spores brown, 2-celled, equal, 7 x 24 μ. The fungus is colonial forming spots .5–3 mm. in diameter.

On *Hillia parasitica.* El Alto de la Bandera, nos. 8569, 8298, 8264, 8706; Monte de Ora, no. 5676.

The ovate perithecia are larger as are also the asci and spores than of *Asterina dilabens.* The measurements of the round perithecia agreed with those of the description given by Sydow.

ASTERINA ACANTHOPODA Speg. F. Guar. part 2, page 47, no. 128.

On *Psychotria* sp. Monte de Ora, no. 5655. On unknown host, Manati, no. 5290.

Asterina versipoda n. sp.

Perithecia round, 224 μ in diameter, brown, distinctly radiate throughout, ostiolate. Mycelium brown, 3–5 μ thick, branched, septate. Hyphopodia 5 x 14 μ, club shaped, alternate. Asci 36 x 50 μ, or 41 μ in diameter, aparaphysate. Spores 12 x 29–34 μ, the superior cell longer. Pycnidia 84–96 μ in diameter, opening by radial fissures. Spores brown, 1-celled, 14–21 μ, some having a lighter band through the mid region.

On unknown host. Utuado, no. 4419.

Near *Asterina megalospora* from which it differs in having straight hyphopodia.

6. ENGLERULASTER v. Höhn. Frag. zur Myk. no. 520

ENGLERULASTER ASPERULISPORA (Gaill.) Th. Ann. Myc. **10:** 171. 1912.

On *Ilex maxima.* Maricao, no. 745. This fungus agrees with the original description given by Saccardo, but does not agree nearly so closely with the description by Theissen. The spines on the spores seem to persist upon fully ripe spores, not to be lost as the spores ripen as is suggested by Theissen.

7. ASTERINELLA Th. Ann. Myc. **10:** 160. 1912

Asterinella hippeastri n. sp.

Perithecia round, distinctly radiate throughout, vertically dehiscent, brown, 120 μ in diameter. Mycelium light brown, 2 μ thick, much branched, septate. Asci 19–21 x 29–31 μ, paraphyses slender. Spores grey-brown, 5–7 x 19 μ, equal celled.

On *Hippeastrum* sp. Mayaguez Mesa, no. 7590.

ASTERINELLA CYLINDROTHECA (Speg.) Th.

On *Eugenia* sp. Rosario, no. 9494; Lajas, no. 7182.

The description given for *A. cylindrotheca* by Theissen fitted the fungus studied on *Eugenia* sp.

Asterinella ixonae n. sp.

Perithecia black, ostiolate, round, radiate, 89–112 μ in diameter, gregarious, hyphophyllous, colonies often 3 mm. in diameter. Mycelium abundant, 2 μ thick, brown, much branched, crenulate, septate. Asci numerous, 9 x 14–17 μ. Spores 2-celled, dark brown, 2–7 x 9 μ.

On *Ixona ferrea*. Mayaguez Mesa, nos. 7591 (type), 7070, 7067.

ASTERINELLA MULTILOBATA (Winter) Th. Hedw. **26:** 25. 1887.

On *Ramurita cocculus*. Laoany, Samar, P. I. Collected by J. C. Ireland. On the same host, but no data as to the time and place of collection.

Asterinella phoradendri n. sp.

Perithecia round, 224–470 μ in diameter, black, carbonaceous, hard. Mycelium scarce, dark, septate, wavy, 5 μ thick, irregularly branched, non-hyphopodiate. Asci 41–55 x 62–84 μ. Spores brown, 2-celled, 17 x 33–41 μ, superior cell broader, obovate, inferior cell tapering toward the free end.

On *Phoradendron* sp. Maricao, nos. 4894 (type), 8717; Las Marias, no. 8228.

Asterinella melastomacearum n. sp.

Perithecia 120–336 μ in diameter, margin fimbriate, carbonaceous. Mycelium crenulate, dark, non-hyphopodiate. Asci 45–48 x 57–72 μ, aparaphysate. Spores 14–17 x 29–36 μ, 2-celled, dark, the superior cell shorter and more rounded. Spores slipper shaped, several vacuoled.

On *Melastomaceae*. Monte de Ora, no. 5745.

8. AULOGRAPHUM Lib. Plant Cryot. Ard. Exs. no. 272, 1834

AULOGRAPHUM CULMIGENUM Ell. Bull. Torrey Bot. Club, p. 65, 1881.

On *Miconia* sp. Mayaguez, no. 3936.

The study of the fungus agreed with the description given by Ellis.

Aulographum cestri n. sp.

Perithecia linear, 26–29 x 96–120 μ. Mycelium dark, branched, 2 μ thick, non-hyphopodiate. Asci round to oval, 19–26 μ in diameter, or 24–31 μ. Spores 2-celled, hyaline, 17–20 x 5–7 μ, aparaphysate.

On *Cestrum* sp. Mayaguez, no. 7576.

9. LEMBOSIA Lév. Ann. Sci. Nat. ser. 3, **3**: 58. 1845

Lembosia portoricensis n. sp.

Perithecia linear, fissure long, 279 x 336 μ, carbonaceous. Mycelium 7 μ broad, brown. Hyphopodia clavate, dark brown, alternate, 7 μ long. Asci obovate, 19–24 x 34–39 μ, paraphyses indistinct. Spores 7 x 17–24 μ, the superior cell shorter and narrower. The fungus is epiphyllous, gregarious, often forming a spot 2–5 mm. in diameter.

On *Coccoloba laurifolia.* St. Ana, no. 7611 (type). Martin Pena, no. 9716.

Asci and spores and hyphopodia smaller than *L. sophorae.* Asci larger than those of *L. pavcltae,* and the perithecia are smaller.

LEMBOSIA TENELLA Lév. Ann. Sc. Nat. ser. 3, **3**: 58. 1845.

On *Coccoloba uvifera.* Boqueron, no. 339c.

LEMBOSIA PHILODENDRI Henn. Hedw. **43**: 89. 1904.

On *Coccoloba uvifera.* Guauajillo, no. 7204.

LEMBOSIA ROLLINIAE Rehm. in herb. Ann. Myc. **11**: 42. 1913.

On *Miconia* sp. El Alto de la Bandera, no. 8639.

The perithecia of the fungus studied was larger than that of the specimen of Rehm. Iodine gave a blue coloring to the fruiting layer.

LEMBOSIA SCLEROLOBII Henn. Hedw. **43**: 265. 1904.

On *Miconia* sp. Anasco, no. 3590.

Asci smaller and perithecia broader than the measurements given by P. Hennings.

Lembosia rapaneae n. sp.

Perithecia straight to T form, 190–336 x 616–672 μ. Mycelium light brown, 5 μ thick, hyphopodia sparse, alternate, subcylindrical. 5 x 7 μ. Asci globose to clavate, paraphysate, 12 x 29–36 μ. Spores 2-celled, brown, with a hyaline spot in each cell, 7 x 21 μ. Paraphyses slender, longer than the asci.

On *Rapanea* sp. St. Ana, no. 7610 (type).

Lembosia sepotae n. sp.

Perithecia carbonaceous, fissure long, 224 x 616 μ. Mycelium dark brown, branched, 2 μ thick. Hyphopodia distinctly lobed, alternate, 7 x 9 μ. Asci 17–27 x 29–34 μ. Spores brown,, 2-celled, equal, 7–9 x 14–19 μ. Paraphyses slender with a globular tip, longer than the asci.

On *Sepota* sp. Manati, no. 5320 (type).

This fungus is near *L. philodendri,* but has smaller perithecia and different hyphopodia.

10. MORENOELLA Speg. Fungi Guaran. **1:** 258. 1883

Morenoella miconiae n. sp.

Perithecia black, fissure long, 145–168 x 235–425 μ. Mycelium dark brown, 2 μ thick, much branched. Hyphopodia cylindrical, 5 x 7–17 μ. Asci elliptical to ovate, 21–31 x 36–46 μ, aparaphysate. Spores dark, 9–12 x 20–21 μ, 2-celled, the superior cell shorter and broader.

On *Miconia splendens.* Las Marias, no. 8145 (type). On *Miconia macrophylla.* Las Marias, no. 8137; on *Miconia prasiana.* Las Marias, nos. 8165, 8160.

Morenoella miconicola n. sp.

Perithecia gregarious, forming colonies 1–7 mm. in diameter, carbonaceous, 313–448 x 470–860 μ; mycelium sparse, 5 μ thick, dark brown. Hyphopodia 7 μ long, hemispherical. Asci 33–43 x 69–84 μ, aparaphysate. Spores 12 x 24–29 μ, 2-celled, brown.

On *Miconia prasina.* Mayaguez Mesa, nos. 7451 (type), 7452.

MORENOELLA DOTHIDEOIDES (Ell. and Ev.) v. Höhn. Fragm. Myk. vol. 8, no. 357.

Synonym *Asteridium dothideoides* Ell. and Ev.

On *Miconia racemosa.* Maricao, no. 8940.

MORENOELLA DOTHIDEOIDES (Ell. and Ev.) v. Höhn. Fragm. Myk. vol. 8, no. 357.

var. **impetiolaris** n. var.

Perithecia black, linear, fissure long, 280–336 μ, gregarious, forming spots 1–1.5 mm. in diameter, on the surface of the leaves. Mycelium 2 μ thick, black-brown. Hyphopodia alternate, clavate to cylindrical, wavy, 5 x 7 μ. Asci ovate, 29–31 x 36–45 μ, aparaphysate. Spores 7 x 19 μ, 2-celled, equal.

On *Miconia impetiolaris*. Mayaguez, no. 7421 (type); Consumo, no. 893.

Morenoella langeriae n. sp.

Perithecia gregarious, carbonaceous, 68 x 414 μ, fissure long. Mycelium 2 μ thick, dark brown. Hyphopodia 5–9 μ long, clavate, alternate. Asci nearly round, 36–41 x 43–48 μ. Spores dark brown, 2-celled, 12 x 24 μ.

On *Langeria resinosa*. St. Ana, no. 6689 (type); Rio Tanamá, no. 7821.

MORENOELLA CALEMI Rac. Parasit. Algen und Pilz, Javas, 3:28. 1900.

On *Epidendrum* sp. Maricao, no. 8809; on *Cresentia cajute*. Mayaguez, no. 972.

Morenoella cestri n. sp.

Perithecia 56–89 x 302–448 μ, carbonaceous, elongate. Mycelium 2 μ thick, brown. Hyphopodia opposite, 5 x 12 μ. Asci aparaphysate, obovate, 5–12 x 12–26 μ. Spores light brown, 3–5 x 9–12 μ, 2-celled, brown.

Host unknown. Quebradillas, no. 4994 (type).

MORENOELLA DECALVANS (Pat.) Th.

On unknown host. St. Ana, no. 6652; Dos Bocas below Utuado, no. 6539.

MORENOELLA DECALVANS (Pat.) Th. var. **rondeletiae** n. var.

On *Rondeletia* sp. St. Ana, no. 6689 (type).

This fungus differs from the type form in its much larger perithecia, 210–640 μ, and its narrower asci, 25–30 μ, and the absence of a denuded center.

MORENOELLA DECALVANS (Pat.) Th. var. **stigmatophylli** n. var.

On *Stigmatophyllum*. St. Ana, nos. 6654, 6552.

This fungus differs from the type in the absence of a denuded center, and from the above in the character of the spot and in the size of the perithecia. These two forms have distinct appearances and perhaps should be given specific rank. In view, however, of their asci and spore measurements, they are placed as varieties rather than as species. The form on *Rondeletia* has its perithecia rather distantly placed, while the other has them smaller and more crowded, thus giving a more complete covering to the leaf and giving the spot a markedly different appearance.

MORENOELLA DECALVANS (Pat.) Th. var. **langeriae** n. var.

Perithecia linear, 190–257 x 316–347 μ, margin fimbriate, carbonaceous, fissure long. Mycelium abundant, brown, 3 μ thick. Hyphopodia sessile, cylindrical to hemispherical, 1-celled, 2 x 9 μ, or 7 μ in diameter. Spores brown, 2-celled, 5 x 21–24 μ, aparaphysate.

On *Langeria* sp. Rio Tanamá, no. 821.

Perithecia were larger than those of *M. decalvans*.

MORENOELLA PORTORICENSIS Speg. Bull. de la Aca. Nat. de Sci. Cordoba **26:** 343. 1923.

On *Ocotea leucoxylon*. Trujillo Alto, nos. 9433 (type), 9436; Homuigueros K. & L., no. 7349; Mayaguez, no. 7393; Monte Alegrillo, nos. 4739, 4726; Mayaguez Mesa, no. 7560; Aibonito, no. 9422. On *Anona* sp.

MORENOELLA POTHODEI var. **laevigatae** n. var.

Perithecia linear, 145–201 x 336–493 μ, fissure large, 56 μ wide, carbonaceous, margin fimbriate. Mycelium 5 μ thick, brown, slightly wavy. Hyphopodia cylindrical, 7 x 12 μ, to globular, 7 μ in diameter, alternate. Asci ovate, 36 x 53–73 μ, aparaphysate. Spores brown, papillate, ovate, 2-celled, 12–14 x 24–29 μ.

On *Miconia laevigata*. El Alto de la Bandera, no. 8689.

The mycelium was thinner and the perithecia smaller than the type. No conidia spores were seen.

Morenoella giganteae n. sp.

Perithecia linear, fissure long, carbonaceous, 302–504 x 784–1064 μ, hypophyllous. Mycelium green-brown, 5 μ thick. Hyphopodia clavate, 9 x 12–17 μ. Asci ovate to spatulate, 33–41 x 84–96 μ, aparaphysate. Spores green-brown, 14 x 26–29 μ.

On *Miconia laevigata.* Rio Maricao above Maricao, no. 3645 (type).

Morenoella melastomacearum n. sp.

Perithecia linear, fissure long, carbonaceous, 336 x 784 μ. Mycelium brown, 5 μ thick. Hyphopodia alternate, sparse, sessile, cylindrical to hemispherical, often hooked, 9 x 14 μ. Asci embedded, oval, 41–48 x 55–72 μ, aparaphysate. Spores dark brown, smooth, heavy walled, 12 x 26–29 μ.

On *Melastomaceae.* Monte de Ora, no. 544 (type).

This fungus is near *M. pothoidei,* but the hyphopodia and perithecia are larger and the asci smaller. No conidia were observed.

Morenoella psychotriae n. sp.

Perithecia linear, carbonaceous, 84–120 x 192–276 μ. Mycelium dark brown, 5 μ thick. Hyphopodia 2 x 9.6 μ, sessile, alternate, rounded. Spores 2 x 9–10 μ, 2-celled, light brown.

On unknown host. Monte de Ora, no. 5664.

11. ECHIDNODES Th. and Syd. Ann. Myc. 2: 436. 1913

Echidnodes bromeliae n. sp.

Perithecia carbonaceous, straight to T form, 201–224 x 481–672 μ, non-hyphopodiate. Mycelium 5 μ thick, sparse. Asci 24–26 x 48–50 μ. Paraphyses not clearly distinct. Spores 7 x 26–29 μ.

On *Bromelia* sp. Rio Tanamá, no. 7913 (type); Maricao, no. 8853; Jajome Alto, no. 8425.

Asci and spores smaller than those of *E. stellatum,* and paraphyses fewer.

Echidnodes mammeae n. sp.

Perithecia 123–145 x 168–280 μ, carbonaceous, fissure long. Mycelium brown, much branched, 5 μ thick, non-hyphopodiate. Asci 17–21 x 24–41 μ, elliptical. Spores dark brown, 2-celled, the

upper cell shorter and broader, 7–10 x 18–19 μ. Paraphyses filiform.

On *Mammea americana.* El Miradero, no. 9139 (type).

12. ECHIDNODELLA Th. and Syd. Ann. Myc. 15: 250. 1917

Echidnodella miconiae n. sp.

Perithecia gregarious, forming colonies 2–10 mm. in diameter, hypophyllous, distinctly radiate throughout, margin irregular but not fimbriate, 81–185 x 105–125 μ. Mycelium light brown, fairly abundant, 1–2 μ thick, non-hyphopodiate. Asci aparaphysate, spatulate, 14–15 x 24–37 μ. Spores 2-celled, dark, 3–4 x 17–20 μ. Pycnidia spores 2 x 11–13 μ.

On *Miconia laevigata.* Aguas Buenas, no. 302 (type).

Echidnodella myrciae n. sp.

Perithecia linear, congregated, 56–78 x 224–336 μ, straight to curved and T form, fissure long. Free mycelium light brown, septate, 5 μ thick. Asci oval to obovate, 9–12 x 14–17 μ, aparaphysate. Spores 2-celled, brown, ovate, 5 x 9 μ.

On *Myrcia splendens.* Jajome Alto, no. 8431 (type).

Echidnodella fourcroyae n. sp.

Perithecia linear, carbonaceous, 112–168 x 324–336 μ, free mycelium scarce. Long fissure present. Mycelium brown, 2 μ thick, septate, non-hyphopodiate. Asci embedded, 24–28 x 33–36 μ, aparaphysate. Spores 2-celled, equal, 9 x 17 μ.

On *Fourcroya* sp. Maricao, nos. 8771, 8822; Calia Baja, no. 9081; Rosario, no. 9499; Maricao, no. 3496.

The fungus is smaller than *Echidnodella camphorae.*

Echidnodella rondeletiae n. sp.

Perithecia linear, carbonaceous, 72 x 288 μ. Mycelium dark brown, 3 μ thick, non-hyphopodiate. Asci 12 x 27 μ, aparaphysate. Spores 2-celled, equal, oval, 2 x 7 μ.

On *Rondeletiae* sp. Monte Alegrillo, no. 4505.

Echidnodella melastomacearum n. sp.

Perithecia scattered, linear, opening by a longitudinal fissure, margin fimbriate, 168–192 x 240–252 μ, gregarious, spots formed about 5 mm. in diameter. Mycelium sparse, branched, brown, 5 μ

thick. Hyphopodia alternate, 1-celled, margin irregular, sessile, 5 x 7 μ. Asci ovate, aparaphysate, embedded, 29–36 x 41–60 μ. Spores fuscous, 2-celled, equal, 9 x 24–26 μ.

On *Miconia* sp. Las Marias, nos. 8160 (type), 812. On *Miconia religinosa.* Maricao, no. 4796. On unknown host Caracas, Ven., nos. 2997, 2993. On *Melastomaceae.* Ponce, no. 4375.

NOTES AND BRIEF ARTICLES

[*Unsigned notes are by the editor*]

A popular illustrated article on Truffles, by W. A. Murrill, appeared in the *Scientific American* for May, 1924.

The fungi collected by the Canadian Arctic Expedition of 1913–18 have been studied and reported upon by John Dearness, who described several as new to science.

A study of decay in Douglas fir in the Pacific Northwest, by J. S. Boyce, appeared as Depart. Bull. 1163 of the U. S. Dept. of Agriculture. *Trametes Pini, Polyporus Schweinitzii, Fomes Laricis,* and *Fomes roseus* are said to be the chief destructive agents.

The mat industry in Japan is largely dependent upon a rush (*Juncus effus decipiens*), which is subject to a stem disease due to a fungus described by M. Kasai as *Cercosporina juncicola.*

A blight of the foliage of gladioli caused by *Bacterium gummisudans* sp. nov. was recently described by Lucia McCulloch in the *Journal of Agricultural Research.*

Potatoes are reported by M. Wilson and others to be attacked by *Armillaria mellea* in Japan and Australia. In one case, the infection was traced to an old sycamore stump.

Strawberry rots in Florida and California are quite different, according to N. E. Stevens, who finds *Rhizopus nigricans* the chief agent in Florida and *Botrytis cinerea* most abundant on the ripe fruits in the west.

The chief cocoa diseases in Trinidad, according to Nowell, who has recently written a book on plant diseases, are die-back, Diplodia pod-rot, algal disease, thread blight, Rosellinia root disease, black pod-rot, and canker.

The development of the fruit-body of *Rhizopogon parasiticus* Coker & Totten is treated in a profusely illustrated article by H. R. Totten in the *Journal of the Elisha Mitchell Scientific Society* for August, 1923.

The genus *Armillaria* is discussed in a recent paper of the Michigan Academy of Science by C. H. Kauffman, who includes in it a number of species usually placed in other genera.

Plants poisonous to insects are discussed in Dept. Bull. 1201 of the U. S. Dept. of Agriculture. Of the 260 species catalogued, only 5% or less are satisfactory from a practical point of view, chief among these being certain species of *Nicotiana, Chrysanthemum,* and *Derris.*

Peony diseases noted in Quebec and Ontario by Coulson are: *Botrytis* blight (*B. Paeoniae*), *Cladosporium* leaf blotch (*C. Paeoniae*), *Septoria* leaf spot (*S. Paeoniae berolinensis*), mosaic, two leaf spots of unknown causation and a disease of the underground parts. The most troublesome of these is said to be the *Septoria* leaf spot.

Spores and pollen grains, according to Stakman and others, are relatively abundant at altitudes up to 11,000 ft. in the Mississippi Valley, but become scarcer at higher altitudes. A few *Puccinia* spores were caught on a spore-trap in an aeroplane 16,500 ft. above sea-level.

The geasters of the United States and Canada are treated by Coker in a very attractive illustrated article in the *Journal of the Elisha Mitchell Scientific Society* for April, 1924. There are 55 pages of text and 19 plates, nearly 30 species being recognized for the region.

"The Clavarias of the United States and Canada," by Dr. W. C. Coker, is a handsome volume of 209 pages and 92 plates, several

of which are colored. The author has collected widely and visited many herbaria in the preparation of this important work, which will at once make the coral-fungi popular with students. Dr. Coker has consented to prepare the manuscript on this group of fungi for *North American Flora.*

GYROMITRA POISONING

In the last week of May, 1924, the Ontario newspapers reported a case of "mushroom-poisoning" under the heading "One dead and two dying from eating Morels." I visited the locality, which is in the County of Norfolk, Ontario, about forty miles distant from my home, and learned without doubt that the "mushroom" gathering had consisted exclusively of lorchels,—*Gyromitra esculenta* (Pers.) Fr.

The father, an intelligent man, assured me that he had in former seasons eaten this fungus, locally known as "elephant's ears," without experiencing any noticeable ill-effects. In preparing them he said that they had rejected all but fresh, clean specimens and as usual they had put them to soak over night in salt-water to be drained off before cooking. Two members of the family had eaten rather sparingly and had not been very ill. He attributed his own recovery and that of his wife and the fatal consequences to his son, aged sixteen, to the fact that in their cases vomition had occurred sooner than in the son's. Death ensued in 48 hours after the meal. The cause, symptoms and progress of the poisoning to its fatal ending were quite similar to those in the case of Mrs. Wm. Blake, near Aylmer, Ont., referred to in MYCOLOGIA 3: 76.

The situation where the collection was made was at the top and half-way down the side of a somewhat sandy bank thinly wooded with pine, hemlock, oak, witch-hazel, &c. The day after the funeral there was still a good crop of fresh lorchels on this slope. The largest one seen measured 17½ inches around its irregular pileus and 9¼ inches from its summit to the base of its stem. The majority of them, however, were of the usual size and bay-red color and looked like clean wholesome food.

JOHN DEARNESS.

BUENOS AIRES Feb. 8, '1924

DR. CARLOS SPEGAZZINI

Yesterday I spent the day with Dr. Carlos Spegazzini at his house in La Plata. He lives at No. 477, Calle 53, in a fine section of the town not far from the principal places of interest and within a short distance of the railway station. His house is immense, with a large patio, or central court, filled with plants and birds. A small green parrokeet is a great pet and makes a lot of noise unless it is continually fondled. It loves especially to sit on Dr. Spegazzini's shoulder and comb out his whiskers with its curved beak. On the left as one enters is the Doctor's study, but he seems to have books and specimens everywhere and we went from one room to another to examine them, keeping the four daughters and the Indian servant girl dodging about to keep out of our way.

Dr. Spegazzini is an old man, but strong in body, young in thought, and still full of the spirit of adventure. He has just returned from Tierra del Fuego, is planning to go to Europe next year, and promises me to come to the United States the following year "if nothing happens." He was born in a village in Italy and was a student of the fungi there before coming to Argentina. He has described a great many South American plants in various groups but his work is poorly known elsewhere and few of his specimens have been seen by other botanists. Like our Dr. Peck, he has been a pioneer in many fields and has had to make his way practically alone, although I find that some of his fungi have been sent to Bresadola, the great mycologist of Trent, in Italy. Like John Torrey, his work has been in Chemistry and his play in Botany, Anthropology, etc. The great Linnaeus was a physician and many preachers, like Berkeley, Curtis, and Schweinitz, have been mycologists. It is good to have a hobby that will take one out into the woods and fields.

The Doctor is exceedingly genial in manner and very kind-hearted. He and his son stayed with me all day long, showing me specimens, photographs, and publications; giving me anything I wanted for our herbarium; taking me out to a sportsman's club for lunch; visiting the museum; and going on a short collecting trip in the woods. We talked French, German, English, Latin, and Spanish indiscriminately and recklessly, keeping up a con-

tinuous flow of conversation lest our ignorance in certain languages be discovered. When we returned from a very hot walk, for the day was unusually warm, one of the daughters had made some excellent ice cream, which we ate greedily.

Seeing the great Natural History Museum at La Plata under Dr. Spegazzini's special care was a privilege and pleasure I shall never forget. The remains of extinct animals, the various races of men, the birds and snakes and insects, with many other things of greatest interest to a naturalist were beautifully displayed and represented by countless specimens. I saw the handsome butterflies for which South America has long been famous and the birds so delightfully described by Hudson. There was a whole case full of the green beetles used in jewelery and Dr. Spegazzini pointed out to me the longicorn beetle that is fast killing the large eucalyptus trees (*Eucalyptus amygdalina*) near the museum. This borer was introduced from Australia with the trees and nothing can be done to stop its ravages.

In an oak grove nearby, where the wild doves were softly cooing, we found our common polypore, *Hapalopilus gilvus,* abundant on decayed white oaks; while beside a lake a little farther on we saw many white poplar trees (*Populus alba*) bent over from the attacks of another polypore, *Trametes gallica,* which feeds especially on living poplars and willows. At the main entrance to the museum building, near some beautiful young trees of the clammy locust (*Robinia viscosa*) with rose-colored flowers, Dr. Spegazzini stopped and sadly pointed to a Ficus tree planted as a memorial to his two older sons killed in the late war in Europe.

I had remarked that Paraguay tea was as yet an untasted beverage so far as I was concerned; so, before leaving La Plata, the Indian girl brought me some in a cup made of horn with a tube of silver through which it is sipped. Then I came away with a large box of specimens, several books, and many pleasant memories. One of these books, which lies before me now on the table, is a thick volume devoted to the Acacia trees and shrubs of Argentina, well illustrated with photographs and drawings, for Dr. Spegazzini, in addition to all his other accomplishments, is an excellent photographer and artist.

W. A. MURRILL.

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MYCOLOGIA

VOL. XVI SEPTEMBER, 1924 NO. 5

SUMMARY OF INVESTIGATIONS ON CLOVER RUSTS [1]

W. H. DAVIS

(WITH PLATE 14)

For more than thirty years, there has been some uncertainty regarding the species of rusts belonging to the genus *Uromyces* parasitizing our common clovers, white (*Trifolium repens* L.), red (*Trifolium pratense* L.), alsike (*Trifolium hybridum* L.) and zigzag (*Trifolium medium* L.). Mycologists and pathologists have generally accepted the fact that the rust on white clover is a species distinct from the rust on red clover but have been more undecided as to the identity of the species of *Uromyces* on alsike and zigzag clovers. Some maintain that the species on white clover also parasitizes alsike and zigzag, while others believe that the rust on red clover parasitizes alsike and zigzag. The existence of pycnial and aecial stages of *Uromyces* on red, zigzag and alsike clovers has also been in doubt. The investigations described below were undertaken by the writer in an effort to answer the questions:

1. Is there one or are there several species of *Uromyces* on white, red, alsike and zigzag clovers?

2. Do the pycnial and aecial stages of *Uromyces* appear on red, alsike and zigzag clovers?

3. What morphological differences are to be found in the rusts on white, red, alsike and zigzag clovers?

[1] After this article was sent to MYCOLOGIA, the author noted in Bot. Abstr. 13: 272, Mr. 1924, under No. 1834 that Kobel has presented a preliminary note on the specialization and morphology of three of these rusts.

[MYCOLOGIA for July (16: 135–202) was issued August 16, 1924]

4. Will inoculations within the host species and reciprocal inoculations with the different spore forms from each host confirm or disprove the opinion regarding the species of *Uromyces* on these four species of *Trifolium?*

HISTORICAL

Howell (4)[1] observed aecia on red clover plants removed from the field and planted in the greenhouse. She believed the aecial stage existed throughout the winter as mycelium and pycnia but she did not definitely state that aecia were observed on red clover outdoors. She believed there is no doubt that the aecial stage on red clover is identical with that on white clover. Inoculations were made with aeciospores and urediniospores but the results were confusing due to the fact that the hosts were not named. Also, the teliospores were not germinated successfully. But she came to the conclusion that the rust on white and red clovers is one species.

Liro (6) showed by his observations and inoculations that the rust on white clover is autoecious, a eu-type and a distinct species from that on red clover, basing his conclusions biologically on inoculations and morphologically on a variation in the number of germpores in the urediniospores. He made no mention, however, of pycnial and aecial stages on red, alsike and zigzag clovers.

Kern (5) directed the attention of American mycologists to Liro's discovery of a white clover rust, *Uromyces Trifolii-repentis* (Cast.) Liro, and a red clover rust, *Uromyces Trifolii* (Hedw. f.) Lév. He stated that the aecial stage found on some other clovers belongs with the uredinial and telial stages of white clover rust as the aecial stage on alsike clover reported by Rostrup in Europe is connected with the uredinial and telial stage of *Uromyces* on white clover. Kern also suggested changes in nomenclature, the discussion of which will be omitted (Table IV).

It is to be noted that considerable uncertainty has existed concerning the spore forms, life histories and species of *Uromyces* on red, alsike and zigzag clovers.

Davis and Johnson (A. A. A. S. 1915) reported the aecial stage

[1] Numbers in parentheses refer to literature cited.

of a rust on red clover; Davis (2) described the aecial stage of alsike clover rust and (3) reported all spore forms of red clover rust on zigzag clover. These reports and additional studies have shown that an autoecious, eu-type rust parasitizes each of the following clovers: *T. repens, T. pratense* and *T. hybridum.*

METHODS

Field observations and collections of *Uromyces* on species of *Trifolium* were made in nine states extending over a period of eight years. Plants infected with the rust were marked and kept under careful observation throughout different seasons. Different clover plants were grown from sterilized and unsterilized clover seeds in the greenhouse and outdoors. Clover plants with stems and leaves infected with *Uromyces* were removed from the field and planted in the greenhouse during the winter and early spring.

Permanent slides were made from leaves of the different hosts bearing all spore forms. Best results were obtained by employing Fleming's fixative and by staining with Fleming's triple stain employing safranin, gentian-violet, and orange G.

Inoculations were generally made by spraying clover leaves with a composite mixture of viable, germinable spores and distilled water but better results were obtained by allowing aeciospores to drop from the aecia onto the wet clover leaflets.

In all spore measurements, special care was taken to obtain " fair spore samples " which were mounted in distilled water while the spores were fresh. Before germpores were counted, the urediniospores were submerged for several weeks, in a solution of lacto-phenol containing crystals of Grübler's säuer grün.

SPORE GERMINATION

The germination of teliospores was given special attention because, as has been stated, the conditions for their germination were unknown. Leaves of white, red and alsike clovers bearing telia were stored in corked bottles lined with damp filter paper and incubated at different temperatures, 6°, 12°, 18°, and 20° C. During each week, the germination of teliospores from these and the outdoor materials was tested. For determining the most favorable

temperature for the germination of aeciospores, urediniospores and teliospores from the different hosts, portions of composite spore samples were placed in distilled water on slides within Petri dishes which were placed in the different compartments of an Altman incubator and in electric ovens.

For one year, weekly spore germination tests were made of outdoor spore materials from white, red and alsike clovers and resulted as follows:

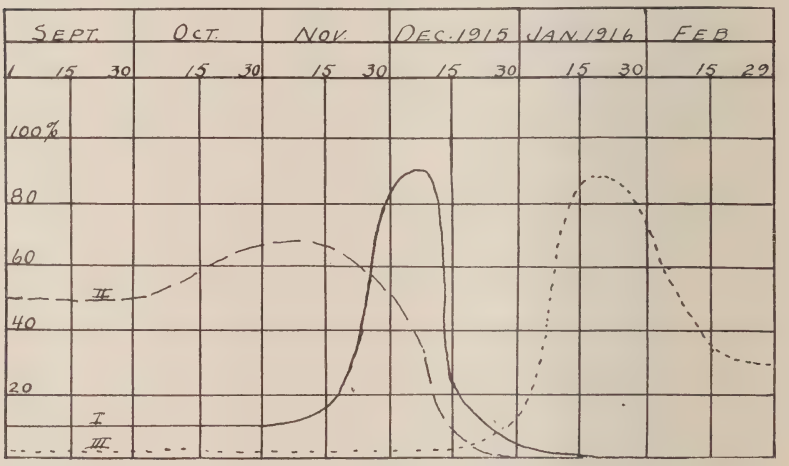

FIG. 1. Curves showing the effect of fall and winter temperatures on the germination of aeciospores, urediniospores and teliospores of *Uromyces Trifolii-repentis* parasitizing *Trifolium repens* (Madison, Wisconsin 1915–1916). I. Aeciospores; II. Urediniospores; III. Teliospores.

1. Aeciospores from white clover germinated about ten per cent in dry weather but the percentage of germination increased after fall rains until December 7 when the temperature was — 14° C. Thereafter, the percentage of spore germination decreased decidedly but aecial material was collected during the first part of the open winter until the severe weather in January. Aecia have not survived the northern winters from 1915 to 1924; however, they have been observed in the field during every month of the year except January, February and March.

2. Viable aeciospores have been collected from red, zigzag and alsike clovers in the field during the months of April, May, June and July only. During these months, each properly conducted

germination test showed a good percentage of germinated aecio spores.

3. Urediniospores from white clover germinated about fifty per cent during the dry summer but germination increased during the cool fall until a sudden drop in temperature to — 14° C. on December 7. Urediniospores failed to germinate in February and have not remained viable in the northern regions where the work has been in progress for the past 8 years. The results for the seasonal germination tests of the urediniospores from red, zigzag and alsike clovers followed closely those already described for white clover.

4. Teliospores from white clover began to germinate during the latter part of December but generally germinated best during the first week in February. A decided drop in the percentage of germination was noted during February, 1916. But during the winter of 1916–1917, the best germination was obtained during the latter part of March. The seasonal variation in the germination of teliospores was greater than for any other spore form tested. A few germination tests showed germinated teliospores during each month of the year but the percentage was sometimes negli-

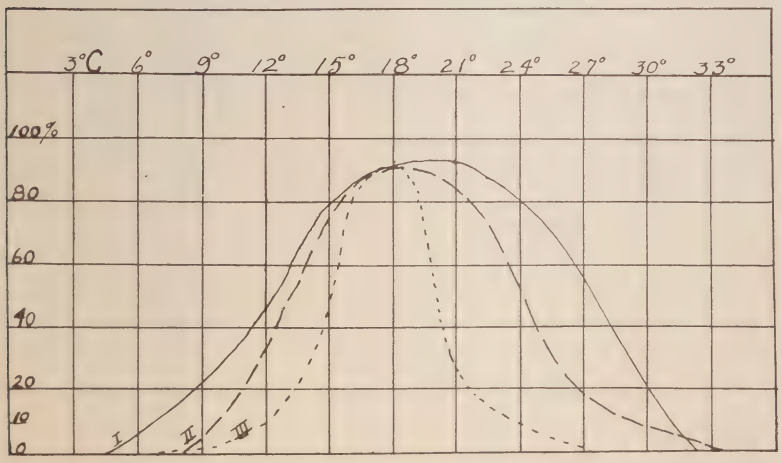

FIG. 2. Curves showing the minimum, optimum and maximum temperatures for the germination of aeciospores, urediniospores and teliospores of *Uromyces Trifolii-repentis* parasitizing *Trifolium repens*. I. Aeciospores; II. Urediniospores; III. Teliospores.

gible. This fact may account for the appearance of aecia throughout the growing season.

5. Teliospores from red clover germinated 10 per cent on January 15; 15 per cent on February 28; 30 per cent, March 15; 50 per cent, April 15; 70 per cent, April 30; 10 per cent, May 15 and 0 per cent, June 1, 1916. Thus the germination of teliospores began in January, was most favorable in March and April but had ceased during the following summer.

Seasonable laboratory spore germination tests of teliospores from zigzag and alsike clovers gave results similar to those described for red clover.

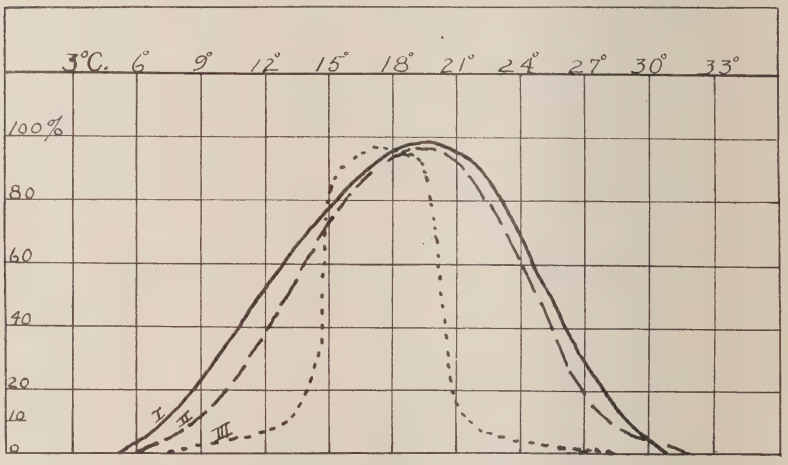

FIG. 3. Curves showing the minimum, optimum and maximum temperatures for the germination of aeciospores, urediniospores and teliospores of *Uromyces Trifolii* parasitizing *Trifolium pratense*. I. Aeciospores; II. Urediniospores; III. Teliospores.

TEMPERATURES: Aeciospores, urediniospores and after-ripened teliospores of *Uromyces* on white, red and alsike clovers were set to germinate under controlled temperatures. Aeciospores from white, red and alsike clovers germinated at a minimum temperature of 6° C.; optimum, 18–20° C.; maximum, about 30° C. This maximum is 4° C. above that reported by Howell. The urediniospores from each of the three clover hosts germinated as follows: minimum, 8° C.; optimum, 19° C. and a maximum slightly above 30° C. Howell placed the maximum at 25° C. The teliospores

from all three clovers mentioned above germinated at a minimum of 7° C.; optimum, 17° C. and a maximum slightly under 30° C. For ascertaining the best temperature for sporidial formation, two trials with teliospores from red and alsike clovers gave the following results: minimum, 10° C.; optimum, 17° C. and a maximum of 21° C. Thus if the formation of sporidia is to be taken into consideration, the range of temperatures for the germination of teliospores is much narrower than that already stated above.

INOCULATIONS

Liro (6) failed to obtain infection on alsike clover inoculated with aeciospores, urediniospores and sporidia from white clover. He did not attempt reciprocal inoculations. As previously mentioned, Liro showed by his inoculations the existence of two rust species, one on white and one on red clover.

The author has made over 100 inoculations with different spore forms from white, red, alsike and zigzag clovers to determine the biological characters and the status of existing species. White, red, zigzag and alsike clovers were each inoculated with sporidia, aeciospores and urediniospores from white, red, zigzag and alsike clovers. The results follow:

1. Aeciospores infected where inoculations were made within the host species, cross-inoculations being unsuccessful on white, red and alsike clovers. Cross-inoculations and inoculations within the species produced infection in red and zigzag clovers. These infections produced the characteristic urediniospores in each case.

2. Urediniospores likewise infected where inoculations were made within the host species, cross-inoculations being unsuccessful on white, red and alsike clovers. Cross-inoculations and inoculations within the species were successful on red and zigzag clovers. Urediniospores produced the characteristic uredinia and old plants showed the presence of characteristic teliospores which were sometimes in the same sorus with urediniospores.

3. Teliospores produced sporidia which infected where inoculations were made within the host species, cross-inoculations being unsuccessful on white, red and alsike clovers. Sporidial infection resulted in aecia characteristic of the host species.

4. Thus, biologically, there is a separate species of *Uromyces* on each of these three clovers, white, red and alsike. The species of rust on zigzag clover is the same as that on red clover.

5. Two inoculations of *Trifolium incarnatum* L., crimson clover, were made with aeciospores, urediniospores and sporidia on germinated teliospores from *T. repens, T. pratense* and *T. hybridum* but no infection was obtained. Repeated injury to some of the plants prevents a definite conclusion at this time.

MORPHOLOGICAL STRUCTURES

Since the inoculations showed there is one biologic species of rust on each of the three clovers—white, red and alsike—observations and measurements were now made to detect variations in morphological structures and the limits of variability for each species of rust. For this purpose, free-hand sections and mounts were made of well developed rusted materials from each of the three hosts bearing all stages of the rusts. Permanent mounts were also prepared by treating each stage of the rust in each host with the same kind of killing solution and employing the same staining process.

TABLE I

COMPARATIVE MEASUREMENTS FOR THE DIFFERENT PARTS OF PYCNIA ON SLIDES PREPARED FROM INFECTED CLOVER LEAVES COLLECTED IN THE FIELD

All measurements are in microns and data are averages from 20 measurements.

Hosts	Diameter Ostiole	Hymenial				
		Height	Width	Surface	Paraphyses	Pycnospores
					(1) 2–4 x 40–65	1.7–2.4 x 2.4–3.6
T. repens....	17	150	120	35	(2) 2.5 x 40	2 x 3
T. pratense ..	25	100	100	25	2–5 x 34–40	2–3.5 x 3.5–5
					3 x 40	3 x 4
					2–4 x 40–85	2–3 x 4–5
T. hybridum .	26	119	119	30	3 x 65	3 x 4

1. Limits.
2. Standards which include over 65 per cent of the specimens measured.

PYCNIA: In comparing the pycnia of the rust on alsike clover with those on white clover, these facts were noted: (See Table I; also Plate 14, *A, E.*)

1. The pycnia in alsike clover are shorter, not extending so deeply into the host tissues.

2. The ostiole is of greater diameter.

3. The hymenial surface is somewhat shallower.

4. The paraphyses are longer than those from pycnia in white clover.

5. The pycnospores are slightly larger.

6. The sizes of the pycnia, pycnospores and diameter of the ostioles compare more favorably with those of the rust on red clover than those of the rust on white clover.

TABLE II

COMPARATIVE MEASUREMENTS FOR THE DIFFERENT PARTS OF AECIA ON SLIDES PREPARED FROM INFECTED CLOVER LEAVES COLLECTED IN THE FIELD

All measurements are in microns and data are averages from 20 measurements. Op. = Aecia opened; Cl. = Aecia closed.

Hosts	Heights	Widths	Peridial Cells					Openings
			Walls		Quotients	Lumina		
			Outer	Inner		Lengths	Widths	
T. repens.....	224	256	2.4–4.8	1–2	3	14–20	8–12	310
			Op. 3.2	1.2				
			Cl. 4.5	1.5				
T. pratense....	168	192	2.4–4.8	1–2.5	2	12–16	8–10	224
			Op. 3.6	1.6				
			Cl. 4.0	2.0				
T. hybridum...	208	208	2–5	1–1.6	2.5	10–14	8–12	140
			Op. 3.2	1.2				
			Cl. 4.0	1.6				

AECIA: (Table II; also Plate 14, Figs. *A, B, D, G, H.*). Aecia on alsike clover are correspondingly smaller than those in white clover, extend deeper in the host tissues, but about the same width as those in red clover.

Measurements of peridial cells varied considerably. When the aecia in all these three hosts were closed, the outer and the inner peridial walls were thicker than when opened. Also the peridial walls were much thicker in sections of fresh aecia made with a freezing microtome and mounted in lacto-phenol than in prepared slides. On account of this variation, two measurements from pre-

COMPARATIVE MEASUREMENTS OF FRESH AECIOSPORES, UREDINIOSPORES AND TELIOSPORES REMOVED FROM FOUR *Trifolium* SPECIES TOGETHER WITH MEASUREMENTS FOR THE PARTS OF GERMINATED TELIOSPORES

All spore measurements are in microns and based on 100 specimens measured.

	T. repens	*T. pratense*	*T. hybridum*	*T. medium*
Aeciospores				
(4) Davis	(1) 16–24 x 20–30 (2) 18–22 x 24–26	13–28 x 17–34 17–22 x 20–26	10–22 x 15–26 17–20 x 21–24	16–26 x 18–28 18–20 x 22–24
(4) Howell	14 x 22	Not reported	———	———
(4) Arthur	15–17 x 16–21	Uncertain	———	———
(4) Sydow	14–18 x 17–21	Not observed	———	———
Urediniospores				
Davis	(1) 15–23 x 15–27 (2) 17–20 x 18–23	18–28 x 20–30 20–24 x 24–26	14–24 x 17–28 20–22 x 22–24	22 x 24 ———
Howell	(3) 14–21 x 21–25	———	———	———
Arthur	18–21 x 21–26	19–23 x 22–26	18–21 x 21–26	———
Sydow	17–24 x 19–26	17–24 x 18–26	17–24 x 18–26	———
Teliospores				
Davis	(1) 13–20 x 17–32 (2) 16–20 x 24–26	12–18 x 18–25 16–18 x 20–24	13–24 x 17–32 17–20 x 24–28	16–20 x 22–32 16–18 x 24–26
Howell	(3) 15–20 x 20–28	———	———	———
Arthur	13–19 x 20–29	16–20 x 20–27	13–19 x 20–29	———
Sydow	16–25 x 18–30	16–25 x 18–30	16–25 x 18–30	———
Sporidia	(1) 5–10 x 8–16 (2) 7 x 10	4– 8 x 5–18 7 x 12	(4– 9 x 5–18) 7 x 14	See *T. pratense*
Sterigmata	3.5 x 5	2 x 5	3 x 4	See *T. pratense*
Promycelia	8–9 x 50–170	8–9 x 68–94	6.8–8 x 48–170	See *T. pratense*

1. Limits; 2. Standards are measurements which include over 65 per cent of the specimens measured; 3. Presumably from *T. repens* but no host stated; 4. Authorities for the measurements.

pared slides only are reported in Table II; namely, in opened aecia and in closed aecia. The measurements of peridial walls in the closed aecia are considered the more accurate for there were fewer variations.

The outer walls of the peridial cells in closed aecia from alsike clover are correspondingly thinner than those in white clover but the inner peridial walls are of about the same thickness. In red clover, the outer peridial walls are of about the same thickness as those in alsike clover while the inner walls are somewhat thicker.

The lumina of the peridial cells in alsike clover are shorter than those in the other two clovers; the widths in all three clovers being comparatively the same.

Measurements of opened aecia on leaves showed that the peridial cells in alsike clover do not normally open vertically or become revolute like those in white and red clovers but remain slightly incurved. Also, the aecia in alsike clover are wider, shorter, the outer peridial walls thinner, and the peridial cell lumina shorter than those in white clover.

The spores from aecia in white clover have been assigned different measurements by different mycologists (See Table III—also Plate 14, *B*). The measurements reported by the writer were made from emitted, fresh aeciospores mounted in water. No great differentiation in size was noted in the spores from aecia on white, red and alsike clovers. Aeciospores from alsike clover are slightly smaller than those from the other three clovers.

UREDINIOSPORES: (Table III; also, Plate 14, *C, F.*) The germpores in the urediniospores of the rust on white and alsike clovers are similar in number, 2 to 4, and similarly placed, equatorial. The urediniospores from the rust on red clover possess 5 to 7 germpores which are scattered. Thus there is a distinctive morphological difference, regarding the number of germpores, between the urediniospores from the rust on white clover and on red clover. However, it is to be noted in Table III that Arthur and Sydow give nearly the same measurements for urediniospores from these two hosts.

Examination of urediniospores from the rusts on white, red and alsike clovers verified the morphological differences as previously

stated. However, the urediniospores from alsike are slightly longer than those from white clover.

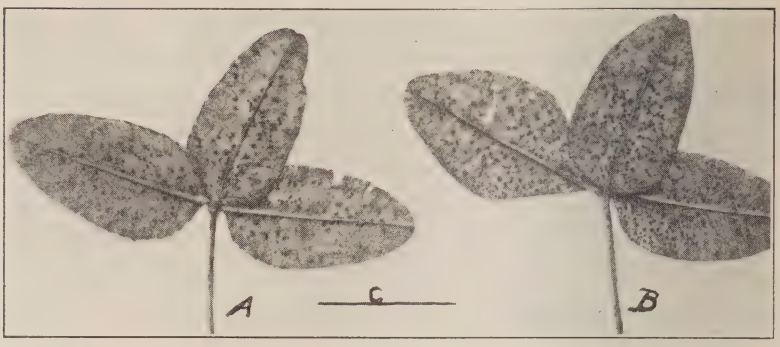

FIG. 4. Leaves of *Trifolium hybridum* bearing uredinia and telia of *Uromyces Hybridi*. A. Leaflets bearing mostly uredinia. B. Leaflets bearing mostly telia. C. Length of a leaflet.

TELIOSPORES: (Table III; also, Plate 14, *C, F.*) No constant, definite morphological differences were noted in the teliospores from the rust on white, red and alsike clovers. The measurements were practically the same save some especially long teliospores were found in samples from alsike clover and, in some samples, the teliospores were of a darker color.

PROMYCELIA AND SPORIDIA: (Table III.) Promycelia from the germinating teliospores removed from white, red and alsike clovers averaged 7–8 μ in diameter, varied from 48 to 170 μ in length and contained 4 to 5 cells. The sterigmata were 2 to 3 μ in diameter, generally widest near the promycelium and from 4 to 7 μ long. The narrowest and longest sterigmata were found on the promycelium from teliospores of red clover rust. The sporidia averaged 7 μ in diameter, 10 to 14 μ in length and germinated at once. The average size of sporidia on promycelia from germinating teliospores of white clover were smallest while those of alsike clover averaged the largest, 14 μ long; otherwise, the germinated teliospores and their parts were similar in size and structure for the rusts on all *Trifolium* hosts examined.

TAXONOMY

Howell classified the rusts on white and red clovers as *Uromyces Trifolii* (Alb. and Schw.) Wint. while Liro showed there are two species on these clovers, *Uromyces Trifolii-repentis* (Cast.) Liro. on white clover and *Uromyces Trifolii* (Hedw. f.) Lév. on red clover.

TABLE IV

GENERA AND SPECIES TO WHICH DIFFERENT AUTHORS HAVE ASSIGNED THE RUSTS ON FOUR DIFFERENT *Trifolium* SPECIES

Authorities	*T. repens*	*T. hybridum*	*T. pratense*	*T. medium*
Liro.....	*Uromyces Trifolii-repentis*	———	*U. Trifolii*	———
Sydow...	*Uromyces Trifolii-repentis*	*U. Trifolii*	*U. Trifolii*	*U. Trifolii*
Kern	*Uromyces Trifolii*	*U. Trifolii*	*U. fallens*	*U. fallens*
Arthur...	*Nigredo Trifolii*	*N. Trifolii*	*N. fallens*	*N. fallens*
Davis....	*Uromyces Trifolii-repentis*	*U. Hybridi*	*U. Trifolii*	*U. Trifolii*

From Table IV, it is to be noted that various authors assign the rust on red and zigzag clovers to the same species but there is a disagreement regarding the species of rust on alsike clover. Kern and Arthur classify the species of rust on alsike with that on white clover while Sydow lists it with the rust on red clover.

In general, mycologists have referred the rust on white and alsike clovers to the same species because, as has been stated, the urediniospores from each *Trifolium* host possess 2 to 4 germpores while those from red clover possess 5 to 7 germpores. The writer believes too much weight has been given to the number of germpores in urediniospores for establishing species in the clover rusts. Should mycologists assign the rust on legumes. *Uromyces Pisi* (Pers.) Wint. to *Uromyces Trifolii* (Hedw. f.) Lév., the red clover rust, because some urediniospores of each possess 5 germpores? Liro was first to point out these differences in germpores for classifying the clover rusts and his classification was adopted by Sydow (Fig. 7). However, Liro was unable to inoculate alsike clover with aeciospores and urediniospores from *T. pratense*.

Thus the classification of the rust on alsike clover has remained unsolved because the aecial stage was unknown and sufficient inoculations were not made to determine its hosts.

As has been stated, the aecial stage of the rust on alsike clover has been observed and inoculations show it to be a separate eutype rust, **Uromyces Hybridi** sp. nov. A description of the organism follows.

Uromyces Hybridi sp. nov.

PYCNIAL STAGE: Pycnia amphigenous, within inflated, yellow areas often grouped on veins of leaf blades and on petioles, light yellow changing to purple then grey, globate, width 119 μ, height 119 μ; ostiole 26 μ in diameter; hymenial surface 30 μ; paraphyses 3 x 65 μ; pycnospores 3–4 μ.

AECIAL STAGE:[1] Aecia amphigenous, in puffed yellow areas on blades, petioles and stipules, sometimes scattered, surrounding pycnia; diameter 208 μ, height 208 μ; peridium yellow, margin slightly incurved, coarsely erose; peridial cells overlapping, lumen 8–12 μ wide by 10–14 μ long, outer wall 2–5 μ thick, average 4 μ and transversely striate, inner wall 1–1.6 μ thick, average 1.6 μ and verrucose; aeciospores globose to ellipsoid-angular, 17–20 x 21–24 μ; wall yellow to colorless, 1 μ, verrucose.

UREDINIAL STAGE: Uredinia mostly hypophyllous, scattered, elongate to roundish, 0.08–0.5 mm. wide by 0.12–0.6 mm. long, somewhat covered by the conspicuously ruptured epidermis, pulverulent, cinnamon-brown; urediniospores ellipsoidal to globose, 20–22 x 22–24 μ; wall cinnamon to hazel; germpores 2–4, equatorial; hilum 5.5 μ.

TELIAL STAGE: Telia mostly hypophyllous, scattered, attenuate-elongate to circular, hazel, 0.14–0.4 mm. wide by 0.17–0.8 mm. long, epidermis conspicuous and persistent; teliospores globose, ellipsoidal or obovate-ellipsoidal, 17–20 x 24–28 μ; wall smooth, clay or ochraceous-tawny, 1.5–2 μ, germpore covered with a hyaline papilla; pedicel clay-colored to colorless, 5 μ wide by 6.4 μ long. Promycelia 3–4 septate, hyaline, 6.8–8 μ by 48–170 μ; sterigmata 3 x 4 μ: sporidia hyaline, smooth, obovate to globose, 7 x 14 μ.

Description of the pycnial and aecial stages of *Uromyces Trilolii* (Hedw. f.) Lév. on *Trifolium pratense* L.

PYCNIAL STAGE: Pycnia amphigenous, grouped, light yellow turning reddish then grey, globate, 100 μ wide, length 100 μ; hymenial surface 25 μ, paraphyses 3 x 40 μ; ostiole 25 μ in diameter; pycnospores 3 x 4 μ

AECIAL STAGE: Aecia amphigenous, grouped with the pycnia in

[1] Davis, W. H. The aecial stage of alsike clover rust. Proc. Iowa Acad. of Sci. 24: 461–472. 1917.

elongated areas on blades, petioles and stipules; color at first golden, changing to gray, 192 μ in diameter, 168 μ high; peridium yellow-white, margin recurved or sometimes revolute, lacerate; peridial cells overlapping; lumen 8–10 μ wide by 12–16 μ long; outer peridial wall limits 2.4–4.8 μ thick, average 4 μ and transversely striate; inner wall limits 1–2.5 μ thick, average 2 μ, slightly verrucose; aeciospores globose to ellipsoid or angular, 17–22 x 20–26 μ; wall light yellow to hyaline, 1 μ thick, minutely verrucose.

SUMMARY

The pycnial and aecial stages of the rust on alsike, red and zigzag clovers have been produced by artificial inoculations, collected in the field and described.

The following morphological differences between the rust on alsike and the rust on white clover were observed:

1. Pycnia from alsike clover are:
   - *a.* Shorter.
   - *b.* The ostioles of greater diameter.
   - *c.* The hymenial surfaces shallower.
   - *d.* Paraphyses longer.
   - *e.* Pycnospores slightly larger.
2. Aecia from alsike clover are:
   - *a.* Wider and shorter.
   - *b.* Outer peridial walls thinner.
   - *c.* Lumina in peridial cells are shorter.
   - *d.* Peridial cells of the opened aecium are slightly incurved rather than revolute.
   - *e.* Aeciospores slightly smaller.
   - *f.* The aecia generally appear on large yellow, puffed areas surrounding pycnia.
3. Uredinial and telial stages from alsike clover:
   - *a.* Urediniospores are slightly longer.
   - *b.* In general, the differences observed in this stage were very slight.

The inoculations with the different spore forms from alsike clover showed:

- *a.* Sporidia from germinated teliospores produced pycnia and aecia on alsike clover but failed to infect white, red and zigzag clovers.
- *b.* Aeciospores produce the characteristic urediniospores on alsike clover but failed to infect the other 3 clovers.
- *c.* Urediniospores produce the characteristic teliospores.
- *d.* Sporidia, aeciospores and urediniospores from white, red and zigzag clovers do not infect alsike clover.
- *e.* The rust on alsike clover is autoecious, a eu-type, and not the same biologic species which infects white clover.

4. Inoculations with spores from red clover showed:

a. Sporidia, aeciospores and urediniospores infect red and zigzag clovers producing in turn the characteristic spore forms. The spores did not infect white and alsike clovers.

b. Sporidia, aeciospores and urediniospores from alsike and white clovers failed to infect red clover.

Inoculations with spores from white clover:

a. These inoculations verified Liro's results and showed the rust on white clover is a different species biologically from that on alsike, red and zigzag clovers; an autoecious, eu-type rust.

Tabulated summary giving the common name for each rust, scientific classification for each organism and name of the host.

Common Name of the Disease	Scientific Classification of the Organisms	Hosts
1. White clover rust	*Uromyces Trifolii-repentis* (Cast.) Liro.	White clover, *Trifolium repens* L.
2. Red clover rust	*Uromyces Trifolii* (Hedw. f.) Lév.	Red clover, *Trifolium pratense* L. and Zigzag clover, *Trifolium medium* L.
3. Alsike clover rust	*Uromyces Hybridi*	*Trifolium hybridum* L.

Therefore, there is a separate species of *Uromyces* with all spore forms on each of these clovers, white, red and alsike. The rust on alsike is not the same as on white clover but a separate species, *Uromyces Hybridi.*

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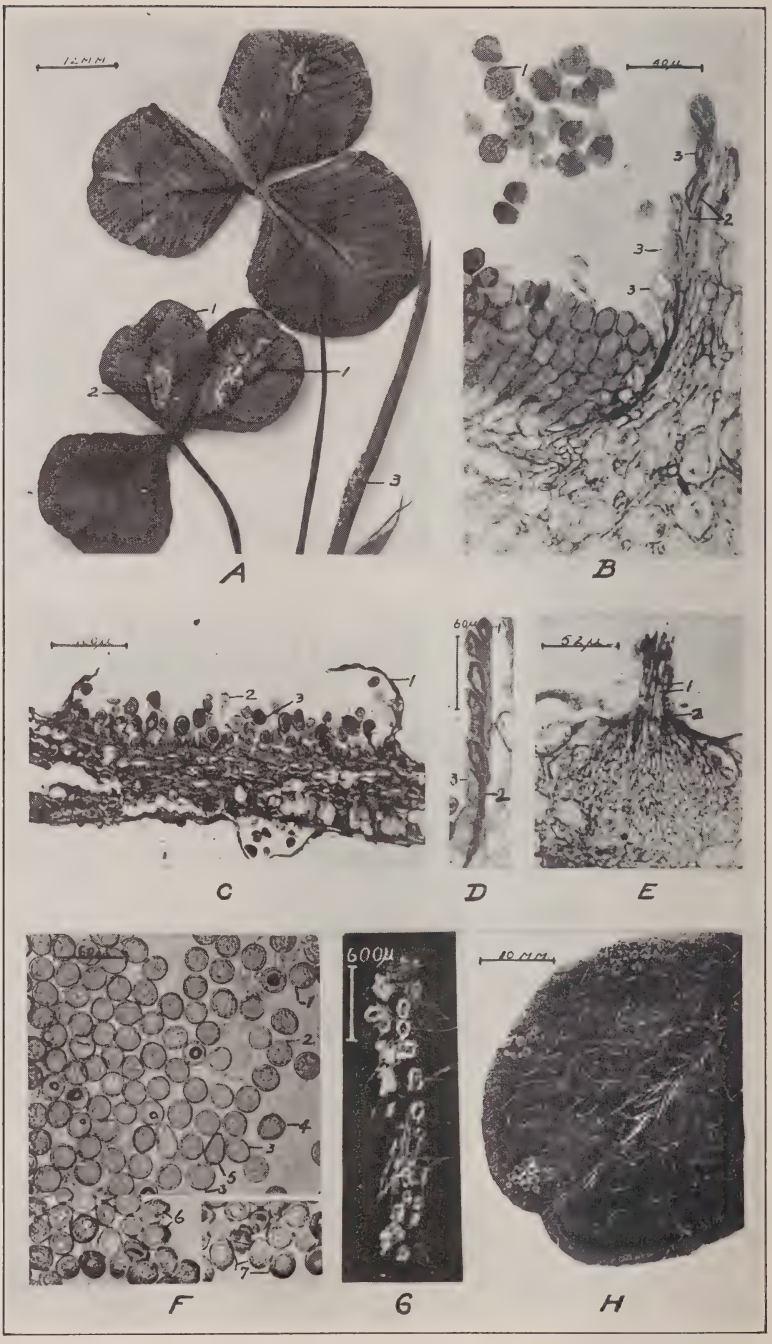
AMHERST, MASS.

LITERATURE CITED

1. **Arthur, J. C.** North American flora (*Uredinales*). **7**: 254–255. 1912.
2. **Davis, W. H.** The aecial stage of alsike clover rust. Proc. Iowa Acad. of Sci. **24**: 461–472. 1917.
3. **Davis, W. H.** Mammoth clover rust. Proc. Iowa Acad. of Sci. **26**: 249–257. 1919.
4. **Howell, J. K.** The clover rust. Cornell Univ. Agr. Exp. Sta. Bull. **24**: 129–139. 1890.
5. **Kern, F. D.** Rusts of white and red clover. Phytopathology. **1**: 3–6. 1911.
6. **Liro, J. I.** Kulturversuche mit *Uromyces Trifolii* (Hedw. f.) Lév. and *Uromyces Trifolii-repentis* (Cast.) Liro. Acta Soc. pro Fauna et Flora Fenn. **29**[6]: 11–15. 1906.
7. **Sydow, P. & H.** Monographia Uredinearum. **2**: 131–134. 1910.



A–F. UROMYCES HYBRIDI ON TRIFOLIUM HYBRIDUM
G–H. UROMYCES TRIFOLII ON TRIFOLIUM PRATENSE

EXPLANATION OF PLATE 14

Photographs and photomicrographs showing various stages of *Uromyces Hybridi* on *Trifolium hybridum* (*A–F*) and *Uromyces Trifolii* on *Trifolium pratense* (*G–H*). *B–F* were photographed from prepared slides.

Figure *A*. Aecia and pycnia on the under side of two young alsike clover leaves.

1. Pycnia on a leaflet.
2. Aecia in swollen areas on the midrib.
3. Aecia on a petiole.

Figure *B*. Section of an aecium from alsike clover.

1. Aeciospore showing the verrucose wall.
2. Outer peridial walls transversely striated.
3. Verrucose inner walls of the peridial cells.

Figure *C*. Section of an alsike clover leaf showing a telium and uredinium on the lower surface.

1. Lower epidermis of the host.
2. Teliospore with pedicel.
3. Urediniospore.

Figure *D*. Peridial cells in an aecium from alsike clover.

1–2. Transversely striated outer walls of the peridium.
3. Inner verrucose wall of the peridium.

Figure *E*. Section of a pycnium in an alsike clover leaf.

1. Long paraphyses extending through the ostiole at 2.

Figure *F*. Urediniospores, from alsike clover, mounted in lacto-phenol containing saüer grün.

1–3. Urediniospore with germpores.
4–5. Teliospores; each bearing a hyaline papilla over the germpore.
6–7. Echinulated surfaces of urediniospores.

Figure *G*. Aecia of *Uromyces Trifolii* on the midrib of a leaflet of *Trifolium pratense*.

Figure *H*. Aecia on a leaflet of *Trifolium pratense*.

THE MORPHOLOGICAL DEVELOPMENT OF ASTEROSPORIUM HOFFMANNI [1]

W. Andrew Archer

(With Plates 15 and 16)

The genus *Asterosporium* and the species *Asterosporium Hoffmanni* were established by Kunze (1) in 1819 from the type species *Stilbospora asterospora* Hoff. Many figures and articles have appeared in various books and journals regarding the nature of this fungus but no one has given an accurate account of spore formation. Fresenius (3) gave a few sketches of the conidia and a short account of the fungus. He states: "Ich habe auf der Tafel, (V. Fig. 13) auch einige noch einfachere jugendliche Sporen abgebildet; das erste Entstehen derselben an den Fäden aber ist bis jetzt von mir nicht beobachtet." Then he quotes from a Herr Reiss, without giving any reference: "auf einem stratum proliferum, das aus hellen schlaffen, einfachen dicht gedrängten Fäden besteht. Diese entwickeln an ihrem oberen Ende ein Bläschen, das bald rundliche Vorsprünge treibt und durch deren Verlängerung zur Spore auswächst." Later Zopf (4, p. 36) refers to this work of Fresenius and makes the statement: "Sehr eigenthümliche Gestaltung zeigen nach Fresenius die mehrzelligen Conidien von *Asterosporium Hoffmanni*. Sie sind nämlich aus 4 kegeligen, in Centrum zusammenstossenden, mehrzelligen Strahlen gebildet. Ueber die Entstehungsweise dieser Conidienform fehlen noch Untersuchungen."

As far as could be determined, this fungus has not been cultured before. It grows rather readily on Leonian's synthetic agar (5). Single spore isolations were made, following the technique for the spray method as given by Kauffman (6). The cultures were made in small capsules (glass dishes of about 25 cc. capacity with loose-fitting lids). The temperature was that of

[1] Papers from the Department of Botany of the University of Michigan, No. 211.

the laboratory. At various stages of development, material was imbedded for microtome sections to study the morphology of the fruit body; while the development and structure of the conidia were determined by teasing out the contents of young fruit bodies and by examination of sectioned material. For staining sections a combination of Delafield's haematoxylin and analin safranin was used.

The collection which formed the basis for these studies was made in April 1923, along the river near Ann Arbor on fallen branches of *Fagus grandifolia* Ehrh.

It requires at least one to four days for conidia to germinate when sprayed on Leonian's agar; many of them germinating even after ten days. A single germ tube arises from the tip of each arm (Pl. 15, fig. 6), but the germination of some of the arms may be much delayed or else may fail to take place at all. These last two facts would indicate that each arm functions physiologically as an individual spore; of this more will be said later. The germ tubes elongate slowly for a few days, laying down an occasional wall (Pl. 15, fig. 7); then they begin to branch rather sparingly at the ends (Pl. 15, fig. 8). Soon the mycelium begins to be evident to the naked eye. It develops rather slowly and scantily, rarely ever covering the entire available surface of the medium. The aërial growth is scanty, confined to the center of the colony and consists of straggly wefts of long, whitish hyphae. Submerged in the medium are formed globose masses of mycelium; these are outlined by the blackened tips of their hyphae. From above, the surface of the culture appears as a whitish mat tinged with brown.

The young fruit bodies are just perceptible to the naked eye after ten days, or even in less time in some cultures. They gradually increase in size forming irregularly globose, superficial bodies that are easily detached from the mycelium. When about half-grown they have a striking resemblance to young colonies of *Nostoc* due to their greenish translucence. Even after mounting in water on a slide they still show this resemblance in that they have a gelatinous tenacity making it difficult to separate them into pieces small enough for microscopic examination. The fruit

bodies are fully mature after about four weeks; when they appear as clustered, black heaps on the surface of the medium.

The primordium of the fruit body arises from a knarl of hyphae after the fashion designated as symphogenetic by DeBary (**12**, p. 247). Such a knarl (Pl. 15, fig. 1) by continued branching of the hyphae increases in size and forms a compacted interior, *i.e.*, the plectenchymatous primordium (Pl. 15, fig. 2). At this stage there is a differentiation of an outer layer made up of ten to fifteen filaments of coarsely interwoven hyphae (this number is only approximate, for as a matter of fact, this wall can vary a great deal in thickness). In mature fruit bodies it is still evident but it is no longer coarsely interwoven; it is more tightly stretched and the individual strands are more or less fused together (Pl. 15, fig. 3).

The first conidia start forming as soon as, or even before, the primordium is well defined, appearing, as a rule, near the center of it. The primordial tissue that initiates conidial formation is stained deeply by the safranin, in contrast with the yet undifferentiated portions. This indicates some constitutional change, probably chemical, in the tissues. There is no definite hymenial layer, for the swollen primary cells of the conidia,[2] each with its attached conidiophore, can be seen lying in all directions, intermingled with the woven hyphal strands of the primordium (Pl. 15, figs. 2 + 4). The early signs of a cavity become evident when these first conidia begin to mature and use up the primordial tissues (Pl. 16, fig. 1). At this time the entire primordium interior is dotted with the initials of young conidia and as spore production proceeds the tissue of the primordium disappears, signifying a lysigenetic action as interpreted by Dodge (**9**, p. 745) and originally defined by DeBary (**12**). Intermixed with these conidia can be found for a time various, irregular fragments of unused primordial tissue. Beyond the periphery of the cavity young conidia are imbedded at various levels in the rapidly disappearing available tissue. Finally this is used up and there remains only the outer layer of hyphae that forms the wall and at this time the fruit

[2] The spores of this fungus are termed conidia because of their position and mode of origin, but they could be termed pycnidiospores with reference to the structure in which they are borne.

body can be said to be mature (Pl. 15, fig. 3). All signs of the disintegrated primordial tissue have disappeared. In old cultures the upper portion of the pycnidial wall dries, ruptures, and falls off leaving an irregular, saucer-shaped lower portion heaped with a powdery mass of conidia.

The young stages of the development of the fungus on its natural substratum have not been observed but there is every reason to believe that they are similar to those just described. Indeed, careful observation of the mature stage on the natural substratum revealed the presence of an outer surrounding wall of hyphae much as it appeared in the cultures (Pl. 15, fig. 5).

A glance at Pl. 15, figs. 2–3 will show that the normal tendency of the fruit body is to be globose. This is due, no doubt, at first to the turgor of the internal compactness of hyphae and later to the great number of conidia. The fruit body in the natural substratum is convex or cushion-shaped merely because it has been confined by the periderm of the bark. In fact it seems clear that it is this tendency of the fruit body to become globose that causes the rupture of the restraining periderm.

The conidiophore is merely a slightly differentiated branch from a strand of the woven hyphae in the primordial tissue (Pl. 15, fig. 4; Pl. 16, fig. 2). The conidiophores are somewhat more slender, as a rule, than the hyphae of the primordium from which they arise, and generally have several septa. As the cavity forms, the conidiophores arise more and more from the remaining primordial tissues at the periphery. A few project in various lengths into the cavity, but most of them are obscurely imbedded in the tissue itself. Finally the whole interior of the pycnidium is filled with conidia, the disorganized primordial tissue has disappeared and the only conidiophores remaining are those attached to the inside of the pycnidial wall (Pl. 15, fig. 3). When the conidia first start forming they are tightly surrounded by the hyphae of the primordium (Pl. 15, fig. 4). It is clear, in the case of *Asterosporium,* that space for spore formation is obtained by the production, from the protoplasm of the actively forming conidiophores and conidia, of some enzyme capable of disorganizing and digesting the surrounding tissue. There is evidence of this disorganization in the fact

that tissues immediately surrounding the conidia stain more deeply with safranin than elsewhere, and by the ragged appearance of the hyphal strands that project into the forming cavity (Pl. 16, fig. 1).

As the free end of the conidiophore enlarges it becomes vacuolated; after a period of swelling the apical portion is cut off from the conidiophore by a septum and thus becomes the primary cell of the conidium; still later a cross wall is formed dividing the primary cell itself into halves (Pl. 16, figs. 3–5). From this point on there is no definite order for the succeeding divisions in the developing conidium. What might be termed the normal order is represented in Pl. 16, figs. 2–9. In the mature pycnidium the four-armed conidium is by far the most common, with the three-armed type constituting the remainder, excepting a very few one-, two-, or five-armed forms. During the development of the four-armed conidium the primary cell first lays down a vertical wall at a slight angle with the plane of the conidiophore, dividing the cell unequally (Pl. 16, fig. 6). Later two other walls form similarly so that a pyramidal segment is left at the center. A diagrammatic side view of such a group of cells is shown in Pl. 16, fig. 13. The three portions cut off in this manner develop into the three respective lower arms by elongation and septation. If the primary cell lays down only one wall, or if two walls are formed with the omission of the third, a three-armed conidium will result. Some of the irregular forms are seen in Pl. 16, figs. 10–12; these, in a mount of young conidia, are by far in the majority but since no such irregularities are found, at least only comparatively rarely, in mature fruit bodies, it is evident that they eventually complete their development. The five-armed form occurs when the basal cell of the top arm produces side arms in much the same way as the primary cell of the normal conidium.

The first stages in the morphologic development of the conidium are best observed from water mounts of fresh material but later, after the spore becomes dark and more complex, it is necessary to use stained sections. A half-mature fruit body teased out on a slide will yield all stages with the exception of fully mature conidia. At the very first the spore initial appears to be entirely hyaline, filled with a clear homogeneous substance, but as soon as

there is any perceptible swelling at the apex, granular protoplasm can be seen pushing up through the conidiophore. As the initial enlarges still further this protoplasm crowds into the spore and a cross wall forms at the base. At each subsequent division of the conidium a portion of the protoplasm is cut off so that in the fully elongated arm the protoplasmic contents have the appearance of a segmented column (Pl. 16, fig. 16). At this point there ensues a differentiation of parts: on the outside there forms a thin exosporium, at first hyaline and soft, but later becoming brown and brittle; at the center of the segment the protoplasm collects in a globose mass, finally surrounded by a definite wall, the endosporium, which is three to four times the thickness of the exosporium; while between the endosporium and exosporium of the lower segments there is a relatively thick, hyaline, faintly staining substance, the exact nature and consistency of which could not be determined. This substance is easily separable, at maturity, from the exosporium and endosporium as seen when the thin exosporium is cracked away leaving it intact or when a cell with its endosporium is crushed out from the conidium. It starts forming near the exosporium and proceeds inward, or in other words, it is deposited by the protoplasmic segments of the young conidium as they round up and become more dense.

At the apex of the arm the exosporium is thickened and marked by a germ pore which is apparently closed by a thin, hyaline, bulged membrane (Pl. 16, fig. 19). In old, dry conidia the flexible nature of this membrane is evident from the fact that it is collapsed inward. The tip of the apical cell projects out into this pore, sometimes touching the hyaline outer membrane.

The cells or protoplasmic units of a conidium are all connected by strands but this is evident only in a state of plasmolysis such as occurs during killing and staining processes (Pl. 16, fig. 17). When the endosporium is fully differentiated it is seen to be tightly pressed against the cross wall. The two lower cells are globose in shape and slightly flattened at the line of contact with the cross walls, while the terminal cell fits tightly into and conforms to the shape of the conical, apical segment (Pl. 16, fig. 18). The two lower cells of an arm, together with the endosporium,

can be separated out by crushing the conidia. Such a loosening of these parts is reported also for *Helminthosporium* by Drechsler (**13,** p. 646). In water mounts of conidia, the protoplasm of these cells is densely granular, with rather small, scattered, hyaline areas of various sizes which, in fully matured spores, are condensed into larger droplets (Pl. 16, figs. 20–21). In stained sections it is possible to distinguish several nuclei within the protoplasm of each cell (Pl. 16, fig. 15); while in the hyphae of the primordium that is actively engaged in spore formation, nuclei undergoing division can be made out (Pl. 16, figs. 14 *a–c*). Their minuteness makes it impossible to see any of the details of mitosis.

The exosporium crushes easily allowing the arms to become broken off and the endosporium units to be released. It must have been an observation of this that lead Kunze (**1,** p. 227) to consider the conidia to be sporangia. He states: "Diese Masse nun besteht, unter starker Linse besehen, aus dunklen, sternförmigen Sporangien, gewöhnlich mit drey, seltner vier und äussest selten fünf kurzen, etwas stumpfen, geschiedenen Strahlen, welche, unter Wasser gequetscht, sehr kleine, längliche, halbdunkle Sporidien ausleeren. Damit werden die Sporangien heller, die Scheidewände deutlicher."

When germinating, the conidium sends out a germ tube from the hyaline, apical germ pore; the contents of a single arm then passes out into this tube. Details are best obtained by the use of oil immersion and sectioned material of germinated spores. The tip of the terminal cell pushes up until it ruptures the hyaline membrane of the pore and then puts forth an irregular and enlarged tube (Pl. 16, fig. 22); this soon elongates and takes on the uniform diameter and appearance of an ordinary germ tube. The tube then forms cross walls in the usual manner during the next few days, as shown in Pl. 15, fig. 7. About this time, it also produces a heavy peripheral wall that becomes brown with age. In sectioned material a cross wall is revealed just within the apical pore (Pl. 16, fig. 23), evidently formed after germination was complete. The formation of the germ tube causes the terminal cell to lose its turgidity so that it collapses and becomes column-like, appearing to be a continuation of the germ tube. Soon after

the apical cell germinates the contents of the second and third cells pass up through unique structures in the cross walls to join in the formation of the germ tube. Such a structure occurs between any two adjoining cells of an arm (Pl. 16, figs. 22–23) and is formed from the modified and thickened portion of the endosporium or inner wall on either side of the cross wall (Pl. 16, fig. 24). Certainly modification has taken place for the portions concerned stain quite differently from the rest of the walls. The opening through the center of the structure connects the cells, probably by definite cytoplasmic canals, recalling the strand-like connections seen between the immature, plasmolyzed segments (Pl. 16, fig. 18).

Each arm functions physiologically as an individual spore because in sectioned and stained material it is possible to find conidia in which one arm has lost its protoplasmic contents by way of the terminal germ tube while the other arms are still unchanged or else just beginning germination. Furthermore actual openings can be seen between the cells of germinated arms when the mounts are properly manipulated.

Each cell, including the one in the pyramidal segment at the very center of the conidium, is capable of sending out an individual germ tube; although this is to be considered as atypical germination, for reasons that are to be presented. If a quantity of conidia are crushed in a manner to fragment the arms and then sowed on nutrient agar, germ tubes may form from any one or all cells (Pl. 16, fig. 25). In such a fragment the germ tube usually passes through the open, broken end, *i.e.*, the path of least resistance. In such a preparation some conidia that have not been broken into fragments will form lateral tubes through the exosporium, this being true even of the terminal cell (Pl. 16, fig. 26). This again would indicate that the germ tubes are following the path of least resistance, that they are issuing through minute cracks or broken places in the walls. This fact is further emphasized when one prepares two sets of cultures for spore germination, one in which the conidia have been thoroughly broken up and another in which the conidia have been carefully handled. In the latter case practically all the tubes will issue through the regular

germ pore. Despite careful handling however, it is conceivable that a few conidia will be injured due to the fragile nature of the exosporium, so, making due allowance for this fact, it may be stated that normal germination is through the apical germ pore only.

The conidia of *Asterosporium* have a few points in common with those of several species of *Helminthosporium* as described by Drechsler (**13,** p. 646). In *H. monoceras* there are apical, hyaline germ pores through which normal germination takes place, although if the exosporium is broken the intermediate segments may germinate independently. In *H. teres, H. giganteum* and several others there are pit-like places in the cross walls and although Drechsler states that he has been unable to demonstrate definitely whether they really serve as connections between cells, he is inclined to believe that they function in that capacity.

In the discussion of pits in cross walls of spores Zopf (**4,** p. 366) gives, as examples, *Thielavia basicola* and the teleutospores of *Phragmidium.* He states that, so far as the former is concerned, the pits do not function in germination. He is inclined to believe that such pores, especially in thick-walled spores, serve as a means of cell sap exchange between cells.

General Discussion

In studying the development of the fruit body of *Asterosporium Hoffmanni* in culture it has been shown that it is a definite globose body with an investing layer of interwoven hyphae; that spore formation originates near the central portion of the primordium and proceeds toward the margins, using up the tissues as it progresses and finally leaving only the enclosing wall of woven hyphae, which persists even in the mature condition. Kunze (**1,** p. 225) and Saccardo (**10,** p. 782) mention a "floccoso" stroma, while Diedicke (**11,** p. 876) describes a "parenchymatischer Basalschict"; in all three cases the reference, no doubt, being to the lower part of the pycnidial wall in connection with the natural substratum. It is more easily seen at this place since the disruption and drying out of the upper portions usually obscures its continuity.

The method of spore formation in *Asterosporium* is a departure from the usual method found so far in the Sphaeropsidales; since in all described forms the conidiophores are arranged in a parallel manner either around the pycnidial cavity or else on a basal layer of tissue, Dodge (**9**), DeBary (**12,** p. 229), and Bauke (**7**); there being of course the exceptions of such simple forms as *Cicinnobolus* and *Fumago,* described by DeBary (**12,** pp. 247, 250) and Zopf (**4,** p. 329). This "hymenium" of parallel conidiophores has been reported regardless of whether the fruit body has a symphogenous or meristogenous origin; Kempton (**8,** pp. 235, 253) has pointed out that the majority of forms so far described are meristogenous. The symphogenous origin of the primordium in *Asterosporium Hoffmanni* is quite similar to that described for *Guignardia Bidwellii* by Reddick (2), and for the *Diplodia* on *Cornus* by Bauke (**7**) but here too the cavity is lined with parallel conidiophores. At no time during the process of spore formation in *Asterosporium* is there any semblance of a genuinely parallel arrangement of conidiophores; instead they are scattered and lie in all directions. Also the outline of the cavity is very ragged and irregular as contrasted with the regularity in other forms.

Asterosporium Hoffmanni, according to the usually accepted schemes of classification, belongs to the Melanconiales, the same being true for the genus *Pestalozzia;* yet we have seen that *Asterosporium* has a differentiated outer wall which in advanced maturity breaks open at the top leaving a saucer-shaped lower portion. Kempton (**8**) has demonstrated the same thing for *Pestalozzia.* These facts indicate the necessity of further knowledge of the early stages of development in many others of the Melanconiales and Sphaeropsidales before final generalizations can be made regarding classification. It is likely with the attainment of such information that many of the present difficulties and discrepancies will be cleared up.

I wish to express my indebtedness to Dr. C. H. Kauffman for his suggestions and guidance in this work.

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LITERATURE CITED

1. **Kunze, G.** Ueber *Stilbospora asterospora* Hoffmann. Flora 2: 225–227. 1819.
2. **Reddick, D.** The black rot disease of grapes. N. Y. (Cornell) Agr. Exp. Sta. Bull. 293: 320, 327. 1911.
3. **Fresenius, G.** Beitr. z. Mykologie pp. 41–42. 1852.
4. **Zopf, W.** Die Pilze, in Schenk's Handbuch der Botanik 4: 18–755. Breslau. 1890.
5. **Leonian, L. H.** A study of factors promoting pycnidium formation in some Sphaeropsidales. Am. Jour. Bot. 11: 19–50. 1924.
6. **Kauffman, C. H.** A contribution to the physiology of the Saprolegniaceae, with special reference to the variations of the sexual organs. Ann. Bot. 22: 361–366. 1908.
7. **Bauke, H.** Beiträge zur Kenntniss der Pycnidien. Nova Acta Leop. Carol. Deutsch. Akad. 38: 443–512. 1876.
8. **Kempton, F. E.** Origin and development of the pycnidium. Bot. Gaz. 68: 233–261. 1919.
9. **Dodge, B. O.** Origin of the central and ostiolar cavities in pycnidia of certain fungous parasites of fruits. Jour. Agr. Research 23: 743–760. 1923.
10. **Saccardo, P. A.** Sylloge Fungorum 3: 782. 1884.
11. **Diedicke, H.** Pilze. In Kryptogamenflora der Mark Brandenburg 9: 876. Leipzig. 1914.
12. **DeBary, A.** Comparative morphology and biology of the fungi, mycetozoa, and bacteria. 1884. Engl. transl. Oxford. 1887.
13. **Drechsler, C.** Some graminicolous species of *Helminthosporium:* I. Jour. Agr. Research 24: 641–740. 1923.

EXPLANATIONS OF PLATES

PLATE 15

Fig. 1. Section through knarl of hyphae showing the symphogenous origin of the primordium.

Fig. 2. Section through young fruit body with investing layer of coarsely interwoven hyphae, the plectenchymatous tissue of the interior and the irregular arrangement of spore initials.

Fig. 3. Enlarged segment from 16, indicating the plectenchymatous tissue and the irregular arrangement of conidiophores.

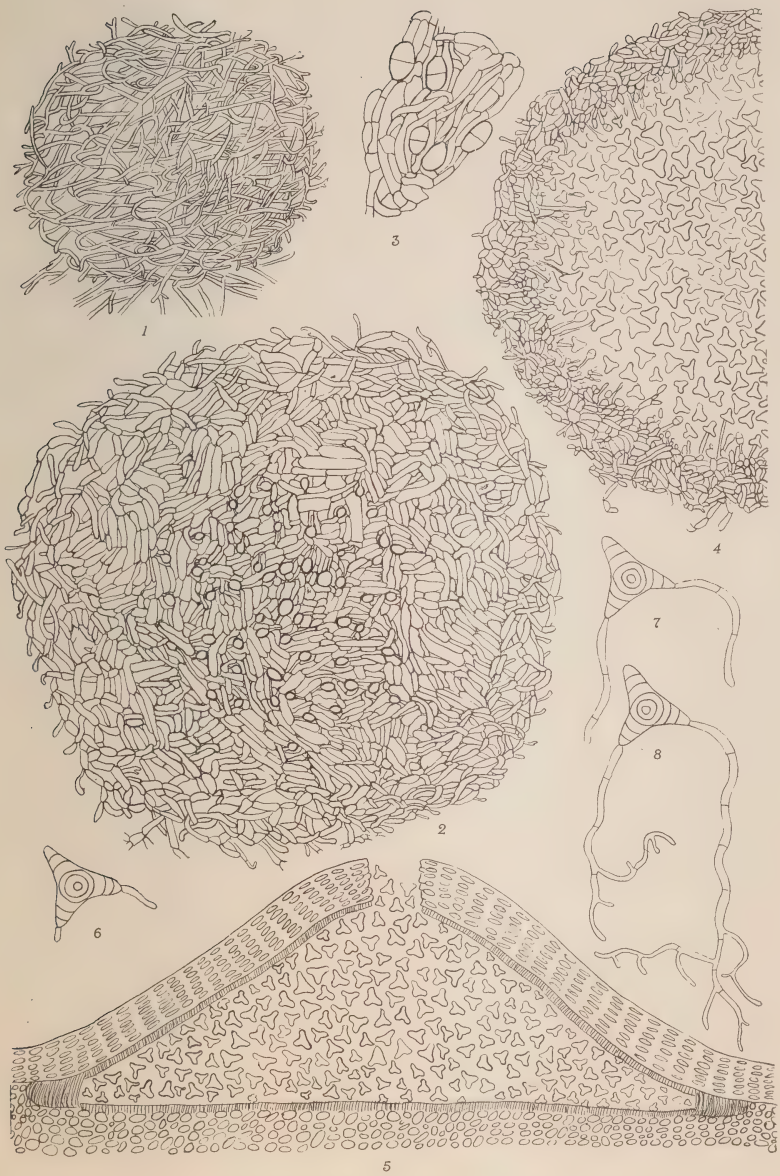
Fig. 4. Portion of section through mature fruit body with large cavity filled with spores. The wall now consists of more or less fused hyphae.

Fig. 5. Mature fruit body on natural substratum. The periderm compresses it into a cushion-shaped form. The surrounding wall of hyphae is present.

Fig. 6. Spore with two arms germinating.

Fig. 7. The germ tubes elongated and segmented by cross walls.

Fig. 8. The germ tubes are branching sparingly at the tips.



ASTEROSPORIUM HOFFMANNI KUNZE

PLATE 16

Fig. 1. Enlarged segment from central portion of fruit body in which cavity formation has started. The lysigenetic action is evident from the space surrounding the conidia and from the disintegrated appearance of the hyphae that project into the cavity.

Fig. 2. Young conidiophore arising from a hypha of the primordium.

Figs. 3–5. Progressive steps in the development of spore initials.

Fig. 6. Formation of the first vertical wall in the primary cell of a young conidium, at an angle with the plane of the conidiophore.

Fig. 7. Formation of second vertical wall of the primary cell.

Fig. 8. Elongation and further septation of arms.

Fig. 9. Mature four-armed conidium.

Figs. 10–12. Types of irregularities seen in immature conidia.

Fig. 13. Diagrammatical view of spore initial indicating the manner in which three segments have been cut off in the primary cell, subsequently to form the three lower arms of the mature conidium, leaving an inverted pyramidal segment at the center.

Fig. 14 *a–c*. Dividing nuclei in hyphal cells from the meristematic region of the primordium. Triple stain. 1.9 mm. oil-immersion lens.

Fig. 15. Single cell from mature conidium showing nine nuclei in the section. Triple stain. 1.9 mm. oil-immersion lens.

Fig. 16. Fully elongated arm with segmented column of granular protoplasm. External view, in perspective.

Fig. 17. Diagrammatical view of a longitudinal section of an arm of an immature, plasmolyzed conidium, just before the endosporium has fully developed. The protoplasmic units have become contracted during fixing, and are shown to be connected by cytoplasmic strands. The stippled portion represents the wall substance laid down by the protoplasm before the differentiation of the endosporium. (Vide figs. 16 and 18.)

Fig. 18. Longitudinal section of mature arm. The endosporium of the lower cells presses against the cross walls. The terminal cell conforms to the shape of the conical segment enclosing it.

Fig. 19. Detail of apical pore, limited by hyaline, protruding membrane above and by dark exosporium below. The tip of the enclosed cell projects above the edge of the exosporium. The exosporium is thickened near the pore. External view.

Fig. 20. Immature endospore unit, separated out from segment of arm, with scattered droplets of oil-like material.

Fig. 21. Mature endospore unit with the droplets condensed into larger areas.

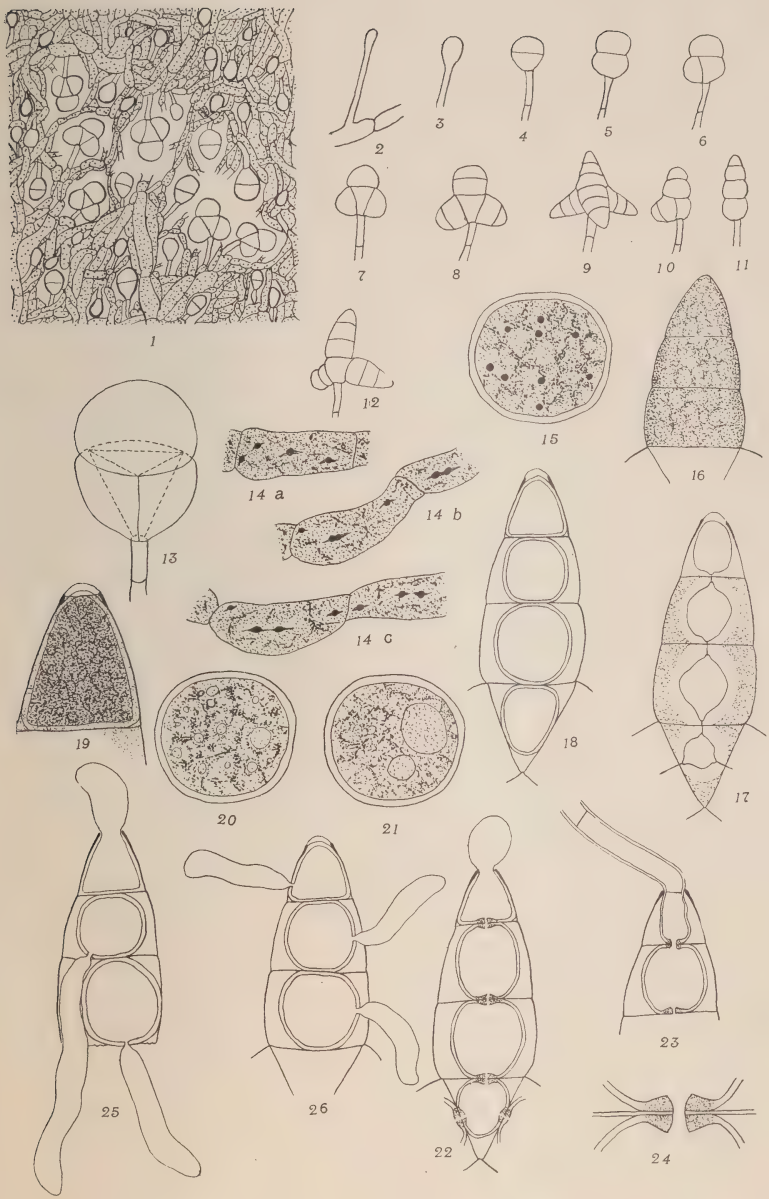
Fig. 22. Longitudinal section of germinating arm. The terminal cell has formed an irregular germ tube. Pores are evident between cells.

Fig. 23. The germ tube has elongated greatly and the terminal cell has drawn away from the exosporium. A cross wall has formed just within the germ pore. The germ tube has formed a heavy, peripheral wall and appears to be a continuation of the terminal cell. The cells are connected by canals of cytoplasm that extend through the cross wall, *i.e.*, through openings in the thickened structures.

Fig. 24. Detailed, longitudinal section; diagram of the structure between cells. It consists of thickened tangent portions of the endosporium on either side of the cross wall, with an opening through the center.

Fig. 25. Fragment of crushed conidium. Germ tubes arise in the lower cells and grow out through the open, broken end; the terminal cell germinates normally.

Fig. 26. A typical germination of a conidium that has been manipulated does not germinate through the regular germ pore.
to crack the exosporium. The germ tubes arise laterally. The apical cell



Asterosporium Hoffmanni Kunze

MYCOLOGICAL NOTES FOR 1921–22 [1]

L. O. Overholts

(With Plate 17)

1. Septobasidium pinicola Snell.

This species was described by Snell in Mycologia **14**: 55–59. 1922, and reported as occurring in New England, New York, and Idaho. I had noted it in abundance in New Hampshire during the summer of 1918 and in a list of species of fungi reported from that state in 1921 noted [2] its general characteristics, though through error the notes were run in under No. 74 of that list, to which it has of course no relation. My specimens were not fertile, and the statement was made that the plants had the appearance of a resupinate *Stereum,* but should have said *Thelephora* instead. Since that date I have observed it in several localities in central Pennsylvania, and I find in the Pennsylvania State College herbarium a collection made as early as 1914, at Charter Oak, Pa. Several other collections have been recently made at localities in the vicinity of State College. The fungus is always on the bark of *Pinus Strobus* and typically on young thrifty trees from ten to thirty years of age where they occur in a fairly dense association. The fungus is well illustrated and described by Snell.

2. Boletus parasiticus (Bull.) Fr.

In the North American Flora and in subsequent citations Murrill lists this species as "occasional in New England and New York." It was collected in Bear Meadows, Center Co., Pa., in

[1] These notes on new and little known fungi are a continuation of similar short papers begun in 1919 and published for that year in Mycologia **12**: 135–142. 1920, and for the following year in Bull. Torrey Bot. Club **49**: 163–173. 1922.

Contribution from the Department of Botany, The Pennsylvania State College, No. 46.

[2] Mycologia **13**: 31. 1921.

the autumn of 1921, on its usual host, *Scleroderma*. By this habitat it is always easily recognized. (Plate 17, fig. 1.)

3. HYPODERMA LINEARE Peck

This species was originally described [3] by Peck as a *Rhytisma* but was later (1878) transferred to the genus *Hypoderma*. Little reference to it is to be found in the later literature. In 1913 Graves [4] noted a fungus on white pine in North Carolina that he thought might be referred here, but seemed to be at the same time only a variation of *H. brachysporum*. He was unable, however, to obtain the ascospores of the fungus.

The writer collected the species on leaves of *Pinus Strobus* in Stone Valley, Huntingdon Co., Pa., July 8, 1920 and again at Greenwood Furnace, Pa., Oct. 29, 1921. When examined microscopically the peculiar shape of the spores attracted attention and the specimen was referred to the above species. Later Dr. House kindly sent me fragments of the type collection at Albany and the reference was verified.

The plant may be said to have at least three characteristics in which it departs from the usual members of the genus. The apothecia produced on the needles are often elongated or linear in form, sometimes reaching a length of 5 mm. Many of them are much smaller, sometimes no more than half a millimeter in length, though many measure about 1 mm. Fertile fruiting bodies of the elongated type are not to be confused with a much more extensive blackening of the leaf that may occur in linear patches along the entire length of the leaf. These blackened areas, while apparently composed of fungous tissue, never develop asci and spores, and such sterile bodies are mentioned by Peck and by Graves, the former stating that "the specimens I have seen are seldom fertile," and again as forming "a thick black line on the lower surface of the leaf, often extending the entire length." The spores furnish a third character of diagnostic importance. They are surrounded by a wide mucous envelope or sheath, that dissolves away and disappears in KOH solution, and in addition are attenuated at the middle, the appearance being that of two large

[3] Bull. Buf. Soc. Nat. Sci. 1: 71. 1873.
[4] Phytopathology 3: 139. 1913.

cells connected end to end by a narrow neck, as pointed out in the original description by Peck. The body of the spore measures 57–70 x 4.5–6 μ as found in the type collection, though measurements of several spores in my material gave an average length of only 45–55 μ. Yet it is easily apparent under the microscope that Peck's material is much more mature than my own. I have not been able to distinguish a cross wall in the isthmus of the spores. These features are brought out in the accompanying illustrations (Figs. 2–6).

Little can be added concerning the parasitism of the species. In one of my collections the fungus was found only on the oldest remaining needles that would normally be shed at the end of that season. In the other case parasitism seemed to be more evident, though in no case were the leaves of the current season damaged. Those of the preceding year were heavily infected and had a grayish wilted appearance, while all leaves prior to those of that season had already disappeared.

4. HYMENOCHAETE AGGLUTINANS Ellis

This is a common species in the Appalachian mountain region, growing on a variety of living hosts. Dr. Burt mentions *Alnus, Benzoin,* and *Acer* as among its usual hosts. *Alnus* and *Betula* are the common hosts in this locality. One collection was made in Laurel Run, Center County, Pa., in 1921 cementing together twigs of *Rhododendron* and *Alnus*. Another collection was taken from *Viburnum dentatum*. On another occasion in 1922 it was found in Bear Meadows, Center Co., Pa., on the trunk of a living hemlock (*Tsuga canadensis*) sapling. The cementing habit mentioned by Dr. Burt as characteristic of the plant is not always present. At least I have found specimens on the trunk of an *Alnus* three and a half inches in diameter on which the fungus forms a large effused patch without evidence at present that its habit was ever a cementing one.

5. PHOMOPSIS JUNIPEROVORA Hahn

This destructive parasite of *Thuja* was found by the writer at State College, Pa., on both *T. occidentalis* and *T. orientalis* during

the season of 1922. In both cases the trees were badly diseased and were dying at the time they were discovered, the upper two thirds of one being entirely dead.

6. WYNNEA AMERICANA Thaxter

A curious specimen of Discomycete was sent in September, 1922, by Rev. E. C. Smith of Meadville, Pa. Dr. Seaver to whom the specimen was referred by the writer determined it as *Wynnea americana.*

The species was published by Thaxter in the Botanical Gazette (39: 246) where that author discusses the other two known species of the genus, one from Mexico and the other from India. The present species was there reported as being found in Tennessee, North Carolina, and Ohio. Although this report is not very recent, probably few if any new localities have been reported for it since that date. Its occurrence in Pennsylvania seems therefore to be of considerable interest. Dr. Thaxter reports that the plant grows from a sclerotium but none were sent with the present specimen. The article previously cited contains an excellent illustration of the fungus. The longitudinal markings on the spores are only faintly visible in sections preserved in glycerine and where best developed give somewhat the appearance of the ridges and furrows on a butternut shell. One point not mentioned in Thaxter's diagnosis is that sections in 7 per cent KOH assume a vinaceous brown color.

7. SCOLECONECTRIA SCOLECOSPORA (Bref.) Seaver

Seaver in the North American Flora reports this species as occurring on various species of pines. I have so far collected it on *Pinus ponderosa, P. Strobus* and *P. sylvestris.* In addition, in April, 1922, it was found in Bear Meadows, Center Co., Pa., on a dead sapling of *Abies balsamea.* It was at first thought that the species might be *S. balsamea* but microscopic examination of the spores (Fig. 8) indicated rather *S. scolecospora,* and Dr. Seaver, to whom a part of the collection was sent, concurred in this opinion. So far as I have seen this is the first record of this species on other than a *Pinus* host.

The parasitism of this species is in need of investigation. The fungus is extremely common on *Pinus Strobus,* but according to the writer's observations is always found on trees that have been injured by other agencies. It is common on young trees of which the leader has been killed by the white pine weevil; it readily follows sun scald injury; and in regions infested with the white pine blister rust it occurs commonly in association with that disease. A certain degree of parasitism is indicated in some of these cases by the formation of definite and often pronounced constrictions developed far beyond that usually seen when these injuries occur alone.

8. VOLUTELLA BUXI (Corda) Berk.

In August, 1922, there were sent in from Bethlehem, Pa., specimens of *Buxus* on which the leaves and the smaller branches were dying. Definitely delimited spots were not formed on the leaves but they appeared to die from the tips back, about half the terminal part of each leaf being dead. In many cases the twig growth for the current year was entirely defoliated. On the lower surfaces of the dying leaves and on the defoliated twigs appeared small waxy, pink or rose-colored fruiting bodies, cushion-shaped or somewhat confluent. Sections through these bodies showed them to be characteristic *Volutella* stromata, with branched, septate

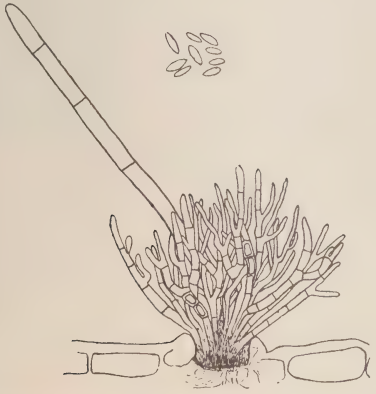


FIG. 1. Section through the fruiting body of *Volutella Buxi,* showing the conidiophores, a seta, and the spores.

conidiophores, cylindric septate setae projecting far beyond the stromata and 8–10 μ in diameter, and elongate-elliptic or narrowly fusoid, hyaline, one celled spores, 6–9 x 2–2.5 μ. There seems little doubt that this fungus is properly referred to *V. Buxi* (Corda) Berk., although the setae are described in Rabenhorst Kryptogamenflora as 4 μ thick, and the spores as 10–11 x 3.5–4.5 μ. More recently Moreau [5] has noted the appearance of the fungus in France and describes the setae as 4–6 μ thick and the spores 10 x 3.4 μ.

Moreau notes that the fungus is parasitic on the leaves, but in the collection cited above a *Phyllosticta* was also present although the two were not fruiting in abundance on the same leaves.

A more recent collection of this fungus was made in 1923 at State College by C. R. Orton.

9. PHYLLOSTICTA CONFERTISSIMA Ell. & Ev.

This species was originally described in 1893 from Louisville, Kansas, on *Ulmus fulva,* and Seaver in the North American Flora notes that it is known only from the type locality. A leaf-spotting *Phyllosticta* was collected by the writer on two occasions in the fall of 1922 at Charter Oak, Huntingdon Co., Pa. One collection was on *Ulmus americana* and the other was simply labeled as on *Ulmus,* and appears now to have been *U. fulva.* In this latter collection the spots formed are rather conspicuously delimited but on *U. americana* they appear more indefinite and of a dark rusty color. The very minute pycnidia are produced in great abundance on the lower side of these spots. The spores are allantoid, bacilliform, 3 x 1 μ. Specimens were sent to Dr. Seaver who verified the determination.

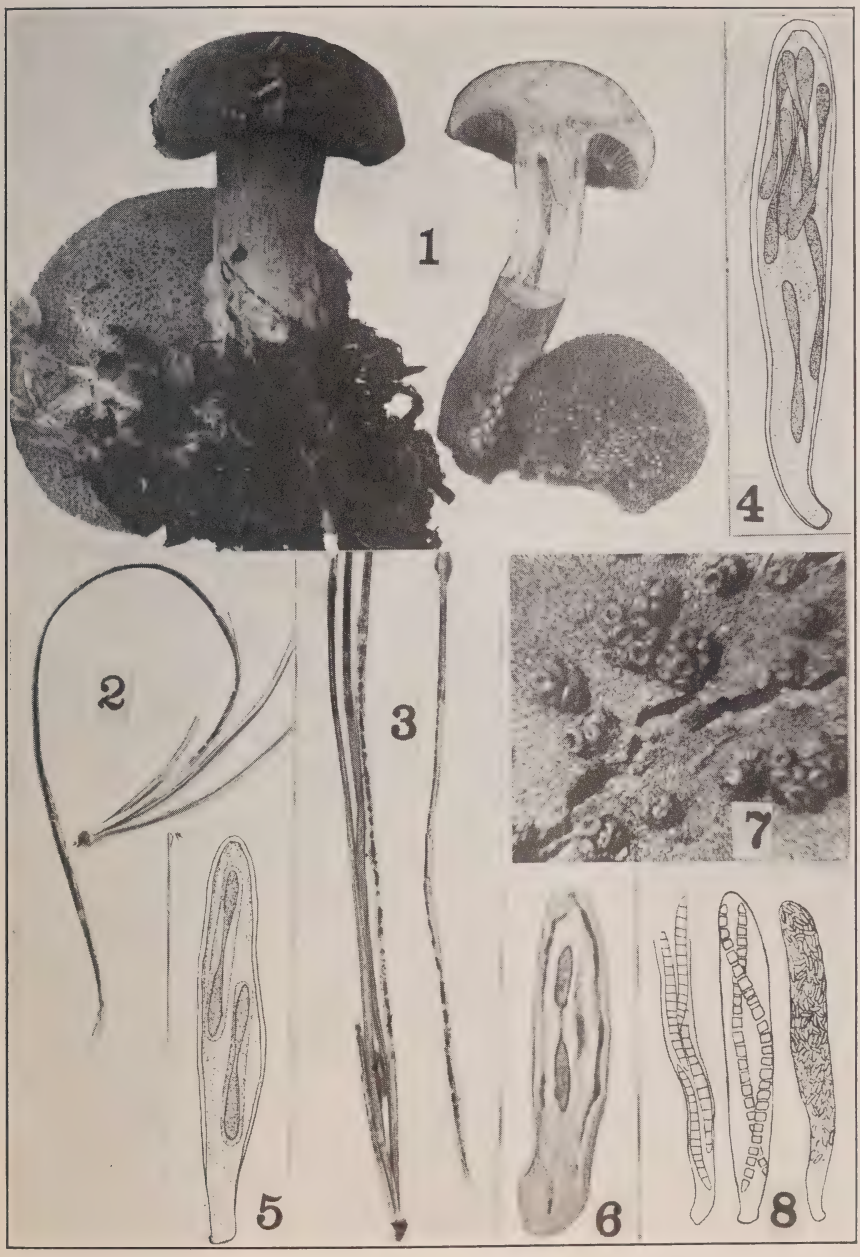
THE PENNSYLVANIA STATE COLLEGE,
STATE COLLEGE, PA.

EXPLANATION OF PLATE 17

Fig. 1. Sporophores of *Boletus parasiticus* attached to plants of *Scleroderma.* $\times$ 1. Overholts Herb. No. *7764.*

FIG. 2. Needles of *Pinus Strobus* bearing apothecia of *Hypoderma lineare.* $\times$ 1½. From the type collection in Herb. N. Y. State Museum.

[5] Bull. Soc. Myc. Fr. 35: 12. 1919.



1. BOLETUS PARASITICUS
2–6. HYPODERMA LINEARE
7–8. SCOLECONECTRIA SCOLECOSPORA

Fig. 3. *Hypoderma lineare* on *Pinus Strobus*. × 1½. Overholts Herb. No. *7507*.

Fig. 4. Mature ascus of *Hypoderma lineare* showing the eight characteristic spores. From the type collection. Drawn with camera lucida.

Fig. 5. Immature ascus of *H. lineare* showing two spores each surrounded by a mucous sheath. From the type collection. Drawn with camera lucida.

Fig. 6. Microphotograph of an ascus of *H. lineare* with a single spore. From the type collection.

Fig. 7. Perithecia of *Scoleconectria scolecospora* on *Pinus sylvestris* showing how they collapse at the apex when mature. Photographed with Planar lens. × 10. Overholts Herb. No. *7985*.

Fig. 8. Three asci showing the various types of ascospores produced. Drawn with the camera lucida. Overholts Herb. No. *7985*.

THREE NEW FUNGI

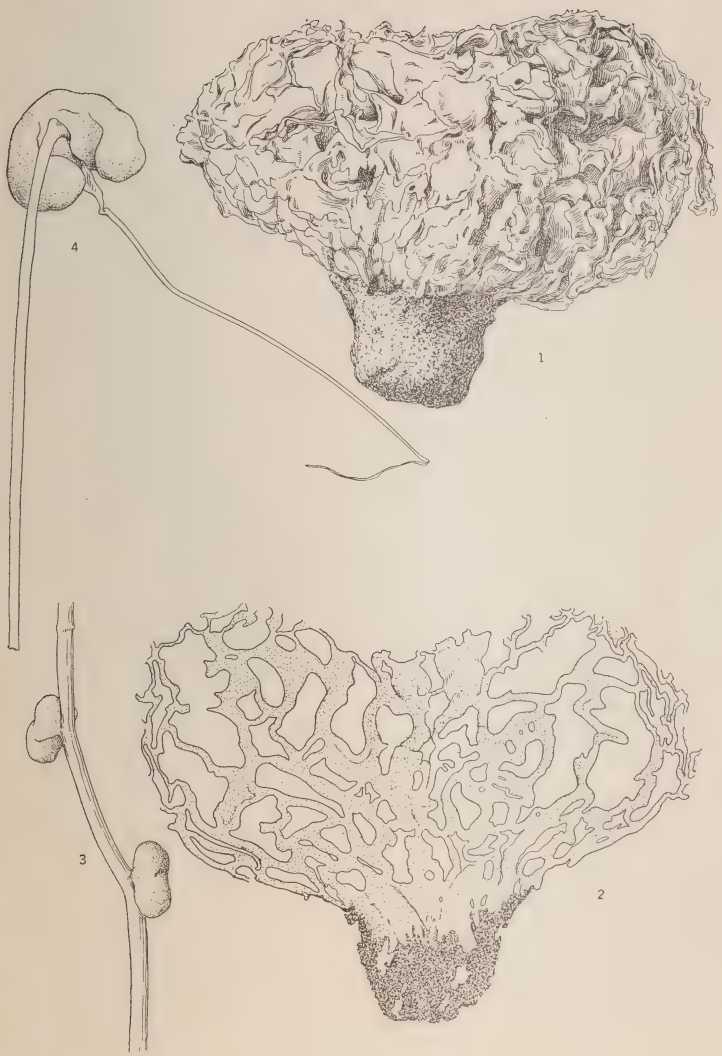
William Albert Setchell

(With Plates 18 and 19)

Daleomyces gen. nov. Balsamiacearum

Ascomata magna, inferne per stipitem et contextam mycelialem curtam robustamque, truncato obconicam affixa, peridio maturitate proprio nullo vestita, interne labyrinthiformi-cavernosa; cameris numerosis cavis, clausis, forma magnitudineque irregularibus, earum parietibus hymenio vestitis; ascis elongatis, cylindraceis, octosporis, paraphysibus intermixtis; paraphysibus moderate robustis, ascos distincte superantibus, earum partibus exsertis flexis; sporis non septatis, oblongis, leviter ruguloso-reticulatis.

I am proposing a new genus of the Balsamiaceae in the sense of Fischer (in Engler und Prantl, Die natürl. Pfl.-fam., 1^1: 288) to receive a very interesting and peculiar hypogaeous fungus which has occurred several times in this vicinity. It is clearly a member of the Tuberales, even in the more limited sense in which the name is often used, and seemingly most nearly related to the genus *Balsamia*. In the adult stages, the only conditions as yet collected, it lacks a distinct peridium, has a definite region of attachment and has rough spores. In these respects, it differs materially from any species of *Balsamia* as yet described. From *Geopora,* it differs in having definite, closed and segregated chambers. It resembles, superficially at least, *Tirmannia* in its shape, definite organ of attachment, general direction of the trama walls, etc., but it possesses hollow chambers. There is something of a resemblance, also, to the more or less hypogaeous species of *Sepultaria* Massee, but that genus is truly a member of the Pezizales and may be looked upon as a sort of compound *Peziza* which has the additional peculiarity of being hypogaeous. We may think of the genus here proposed as a farther development of the *Sepultaria* type in much the same fashion as we may look upon *Geopora* as a more complicated development of a simple *Peziza* and upon



1–2. Daleomyces Gardneri Setchell
3–4. Thecaphora Ruppiae Setchell

Balsamia as the most complete development of the same type in the general direction of a typical member of the Tuberales.

The generic name is given in honor of Lawrence Dale Parks who discovered and kept under observation some of the best specimens obtained.

Daleomyces Gardneri sp. nov.

Ascomata carnosa, alba ad dilute violascentia, late turbinata, 6–9 cm. alta, 9–12 cm. lata, exteriore profunde corrugata, inferne in stipitem latam affixantem abrupte attenuata; cameris formaque magnitudineque variantibus, cavis, earum parietibus hymeniis vestitis; ascis cylindraceis, 220–250 μ altis, 8–12 μ latis, octosporis; paraphysibus ascos superantibus, moderate robustis, supra ascos lente tumidis et abrupte flexis, inferne rectis septatisque, 228–250 μ altis, 4 μ latis; ascosporis oblongo-ellipsoideis, 10–12 μ longis, 4–5 μ latis, leviter sed distincte ruguloso-reticulatis.

In earth (sandy), mixed with street sweepings, barely breaking through at the surface, Golden Gate Park, San Francisco, California, N. L. Gardner, No. *188*, Feb. 29, 1904; in similar habitat, University of California Campus, Berkeley, California, L. Dale Parks and H. E. Parks, No. *1412*, January 1923.

The plant described above is certainly puzzling in its general appearance and inclines one at first sight to refer it to the Pezizales, but its technical characters are clearly with the Tuberales. Its large size, fleshy consistency, whitish to pale violet or lavender color, its habit of showing itself only at maturity and then simply by slightly elevating and cracking the surface of the soil, all these contribute to its strange appearance. At Golden Gate Park, it was found in sandy soil richly fertilized with street sweepings. The locality in Berkeley showed a somewhat heavier soil and was situated where it received some street sweepings although much less than the locality in Golden Gate Park. It is hoped that more specimens may be discovered and in less mature stages.

Acrospermum candidum sp. nov.

Perithecio e macula myceliali tenui, pallida areolataque oriendo, prope 1 mm. alto et 0.2–0.3 mm. in parte latissima crasso, superne candido inferne dilute melleo, breviter stipitato, supra stipitem moderate aut definite ampullaceo, superficie (supra stipitem)

primo laxe squamato deinde regulariter areolato, haud compresso, apice orbiculate aperto, humido lente, sicco plane curvato; ascis dense stipatis paraphysibus intermixtis, longe cylindraceis, gracillimis, parallelis, octosporis ?, usque ad 500 μ longis, circa 8 μ latis; ascosporis elongatis, angustissime cylindraceis, hyalinis, septatis, circa 400 μ longis et 1 μ crassis, in ascis laxe spiraliter aggregatis; paraphysibus elongatis, gracillimis, lente flexuosis, circa 500 μ longis et 1 μ crassis.

On the undersides of living, but sterile leaves of *Alsophila quadripinnata* (Gmel.) C. Chr., collected at high levels, Cerro de Boqueron, State of Chiapas, Mexico, by Dr. C. A. Purpus (on No. *6715*), Sept. 1913.

The species described above is closely related to *Acrospermum Maxoni* Farlow (cf. Riddle, MYCOLOGIA 12: 179, Jl 1920), but differs from it in the color of the perithecium, in not being compressed and in its spirally arranged, septate spores. The scanty mycelium, superficial on the under surfaces of the pinnules of the host, shows in the earlier stages distinct hyphae whose walls seem to gelatinize so as to make the whole mass structureless at maturity. The mycelial fleck, at that time, becomes areolate sometimes showing the irregularities of the leaf surface. The short stipe is, at maturity, light honey colored and is in contrast with the shining white of the portions above it. The surface of the perithecium above the stipe disintegrates and peels off forming irregular scales. When the surface is finally denuded, it seems to have, when dry, an alveolate appearance. It is difficult to determine the exact number of spores and their length, but there seem to be eight, spirally twisted within the ascus, and, at maturity, distinctly septate. The figure of the ascus and its spores presented with this account is of a young ascus and is somewhat diagrammatic. In older asci, the spores are closer together, the spiral arrangement is more pronounced, the septation is more definite, but the course of the individual spore is difficult to follow. In the wet state, the perithecia are only slightly curved, but when dry, they are generally completely recurved. The finding of a second species of this genus on living ferns may indicate the possibility of there being even more of these interesting almost microscopic fungi to be looked for.

Thecaphora Ruppiae sp. nov.

Excrescentia irregulari tuberculoidea in caulibus foliisque *Ruppiae maritimae* usque ad 1 cm. diam. formans; sporis in intertextiis mediis excrescentium dense aggregatis, plerumque quaternis, sed aliquando binis, agglutinatis, prope globosis, 4–6 μ crassis, parietibus crassis, levibus, fuscescentibus indutis.

While carrying on some cultures of *Ruppia maritima* var. *rostrata* Ag., my attention was attracted by some rather conspicuous galls forming here and there all along the stems and along the slender leaves. The Ruppia came, as seeds, from a brackish pool near the Power House at Alto in Marin County, California. At first, the galls were of a light green color and more or less translucent, but after a while, they changed to a dirty brown color. I have been able to obtain traces of the mycelium in the gelatinized condition. The spores are formed in dense layers surrounding the cells of the tissues of the galls intermediate between the central and the outer tissues. In slightly crushed material, the aggregations of spores seem to take the form of hollow spheres. This is due to their being formed around the rather large and swollen cells of the intermediate tissue layer of the gall. On farther crushing, the spores separate into the final aggregates which are largely in fours, but sometimes twos and uneven higher numbers are represented. The character of the spore aggregation places the species in the genus *Poikilosporium* of Dietel (cf. Flora 83: 87, 1897), but most writers seem inclined to unite that genus with *Thecaphora*. Unfortunately I have been unable to obtain the germination of the spores in my plants and the genus must, therefore, remain uncertain. It is of special interest to add a new species to the few known aquatic Ustilaginales.

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EXPLANATION OF PLATES

PLATE 18

Daleomyces Gardneri gen. et sp. nov.

Fig. 1. Ascoma in surface view, seen from the side. $\times$ 0.75.
Fig. 2. Ascoma seen in median vertical section. $\times$ 0.75.

Thecaphora Ruppiae sp. nov.

Fig. 3. Galls on the stem of *Ruppia maritima* var. *rostrata* Ag. × 2.5.
Fig. 4. Gall on the leaf of the same species. × 2.5.
All figures drawn by Miss Anna Hamilton under the direction of W. A. Setchell.

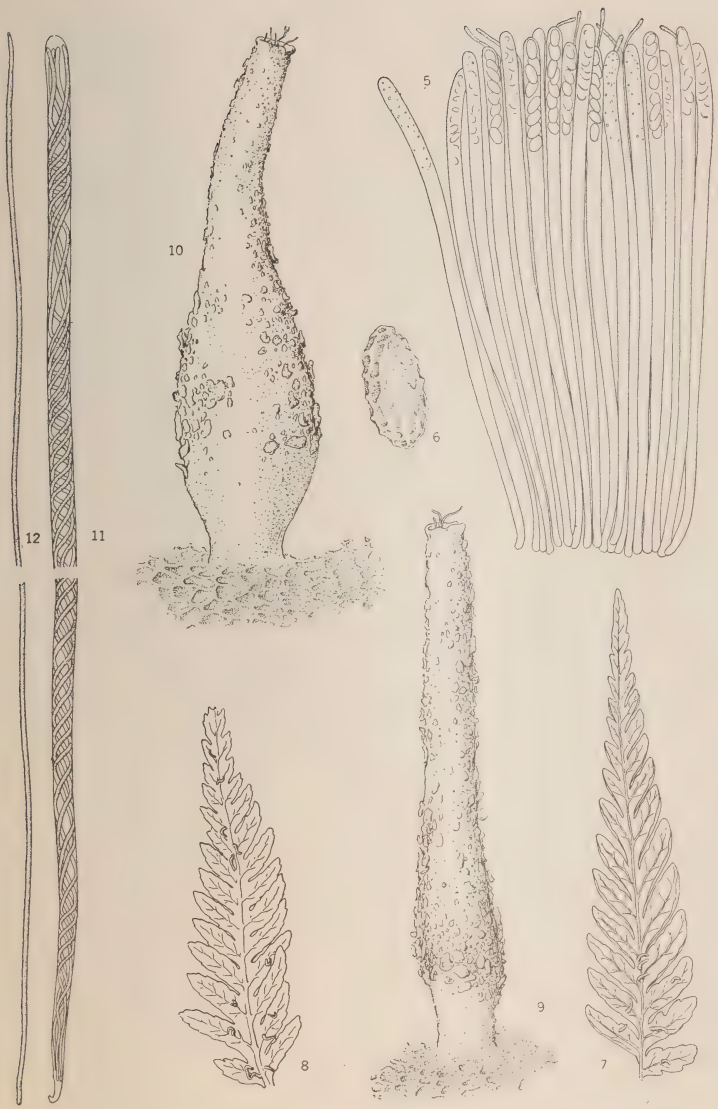
PLATE 19

Daleomyces Gardneri gen. et sp. nov.

Fig. 5. Asci and paraphyses. × 165.
Fig. 6. Ascospore. × 1300.

Acrospermum candidum sp. nov.

Fig. 7. Pinnule of *Alsophila* seen from below and showing the perithecia in moist condition. × 1.
Fig. 8. Similar pinnule showing the perithecia in dry condition. × 1.
Fig. 9. Perithecium and portion of basal mycelium seen from the side. × 9.
Fig. 10. Similar view of an older perithecium. × 9.
Fig. 11. Ascus showing upper and lower portions. × 500.
Fig. 12. Paraphysis showing upper and lower portions. × 500.
All figures drawn by Miss Anna Hamilton under the direction of W. A. Setchell.



5–6. DALEOMYCES GARDNERI SETCHELL
7–12. ACROSPERMUM CANDIDUM SETCHELL

FERN RUSTS AND THEIR AECIA [1]

J. C. Arthur

The rusts in general, a well circumscribed and readily recognized group of parasitic fungi, have not yet been assorted under any generally accepted classification, although the process of placing them in genera, families, orders, etc., has been actively proceeding for considerably over a hundred years. There are more than a thousand species of rusts in North America under about eighty genera. So great is the disparity in views between the most capable and advanced thinkers that there is no unanimity regarding what forms may be taken to represent primitive or ancient states, and what the most recent, specialized states. It is the situation the phanerogamic botanists were in before it was decided whether the cone-bearing plants (gymnosperms) were more suitably placed before all other flowering plants, in the middle, or at the end of the series. So long as the mycologists can not agree whether a short cycled form, like *Puccinia Xanthii* with its single stage and one kind of spores, is representative of rusts in their primitive condition in early geologic times, or a long cycled form, like *Puccinia graminis* with its several stages and diversity of spores, there is no hope for an acceptable classification of the rusts. If one were so blind as to be unable to tell which was the head and which the tail of a dog, there would be justifiable uncertainty as to the direction he would be likely to move.

It may be said that there are two classes of uredinologists, or students of the rusts. There are those who believe the rusts have progressed from a simple, one-spored condition in their early phylogenetic history, to the highly complex and heteroecious condition now known among many of them; and there are those who believe that the most ancient rusts had many kinds of spores and

[1] Presented before the Mycological Section of the Botanical Society of America at its Cincinnati meeting, December 28, 1923.

Contribution from the Botanical Department of the Purdue University Agricultural Experiment Station.

spore structures, and flourished upon a diversity of hosts, that by progressive development *pari passu* with the development of their hosts on the one hand, and the restrictive action of parasitism on the other, they have acquired great diversity of individual forms, but at the same time have become more and more specialized as to hosts and more and more reduced in their life cycles to fewer stages, in many cases even to a single spore stage without even the trace of a pycnium, the vestigial remains of a sexual structure, or even to the still greater simplification of a complete uninuclear, sexless condition. This problem of the progressive development of the rusts has nothing to do with their origin. It starts with the primitive rusts after they had acquired the characteristics of rusts with their parasitic habits, and loss of active sexuality. Their origin is another problem.

The problem in hand has been most commonly attacked from the morphological side, and this has been supplemented in late years especially by cytological studies. But there is another way of approaching the problem. The strict parasitism of the rusts has always been a dominant factor in their development, much as sexuality has been in higher plants. We should therefore expect that the rusts on the most ancient line of hosts would be likely to reveal more primitive features than those on hosts of later origin.

There is no question but that the ferns have the most ancient lineage of all the hosts of the rusts. If we study the fern rusts we ought to be able to get some clues to the character of the ancient forms. Most unfortunately there are only a few rusts known on ferns, and these have been the discoveries of recent years, although there is little doubt that many species exist and await the collector. Of those known only three kinds have had their life cycles fully traced out, and the imperfect state of our knowledge regarding the others must be pieced out by analogy.

The rust-bearing ferns belong to three families: the small family of the *Osmundaceae,* or cinnamon-ferns, much the oldest geologically, extending back into the Triassic and even the late Paleozoic and showing certain morphological resemblances to still older forms; the *Polypodiaceae,* containing the great majority of the ferns, but not so ancient, extending only to the Jurassic; and

the small family of the *Schizaeaceae,* or climbing ferns, geologically comparatively modern, although known in the Jurassic.

Now, to take up the rusts, let us begin with those found on the representatives of the most ancient known family of ferns, the *Osmundaceae.* Only one species occurs, *Uredinopsis Osmundae.* The genus *Uredinopsis* contains about ten intergrading species, which could with propriety be called varieties of one species, one form being on the genus *Osmunda,* and the other forms upon various genera of the *Polypodiaceae.* This is the first genus of fern rusts to be recognized, having been founded by Magnus of Germany in 1893, although some of the spore forms had received names under the genera *Protomyces* and *Septoria* as early as 1873, and *Gloeosporium* in 1880, clearly showing that for awhile they were not recognized as belonging to the rusts. The genus *Uredinopsis* is also the first of the fern rusts to have its life cycle fully worked out, which was done by Fraser (MYCOLOGIA **4**: 189 and **5**: 233) of Cananda in 1912, who produced the white spored *Peridermium* on balsam fir (*Abies balsamea*) by placing the germinating teliospores of *Uredinopsis Osmundae* upon leaves of the fir. The characteristic pycnia and aecia appeared on the fir within two or three weeks. Four other species of the genus were similarly cultivated the same season, using partly teliospores and partly aeciospores for sowing. Let it be noted that the aecia inhabit a member of the *Abietineae,* one of the oldest families of coniferous plants.

What other evidence beside the association of hosts can be adduced that the rust on *Osmunda,* and similar forms, is representative of a primitive condition? In the first place all the spores and spore structures in the genus *Uredinopsis* are colorless; the characteristic yellow-brown coloring matter of rusts in general not having developed. Secondly, the teliospores are more or less scattered through the soft tissues of the host and do not arise from a well defined spore structure coming from a compacted primordium, as in most other rusts. In the third place, the urediniospores are markedly dimorphic, which does not occur among rusts outside of those on ferns. Both are characteristically conidial, and one of the forms is most unusual, reminding one of some of

the ascomycetous fungi imperfecti, the spores being beaked and discharged as white vermiform threads. These spores are probably catenulate in origin, while the other form appears to be pedicellate and pulverulent, furthermore both forms have thin walls without evident germ-pores or the usual echinulation. It must be granted that these characters have a primitive aspect and are indicative of forms as ancestral and primitive as any we yet know among the rusts.

If we take *Uredinopsis Osmundae* as our best representative of the ancient rusts, let us name over the prominent features that an ancient rust, at least with this ancestry, must have had. To start with it was long cycled, having all the spore forms well displayed; pycnia, aecia, uredinia and telia. The pycnia were either subcuticular or slightly sunken beneath the epidermis, the aecia had spores in chains and a protective peridium, the uredinia had a less developed protective structure, with spores of two sorts, one apparently catenulate and the other pedicellate, both admirably designed for a conidial habit of repeating the generation, and the telia were thin walled and without the usual surface sculpturing. Finally the rust had the haploid and diploid generations well dissociated, one being developed on coniferous plants and the other on ferns.

Turning to the other fern rusts we find that *Hyalopsora,* a genus established by Magnus in 1901, having about the same number of species as *Uredinopsis,* but better differentiated, is developed entirely on the *Polypodiaceae.* The full life cycle for one of the species is known, and is likely to be typical of all others in the genus. Like *Uredinopsis* the rust is heteroecious, with aecia on *Abietineae,* being on firs (*Abies pectinata* in Europe and *A. balsamea* in America). The pycnia are subepidermal and well sunken in the tissues; the aecia like those of *Uredinopsis* have a well developed peridium; the uredinia are dimorphic, but not so strongly so as in *Uredinopsis* and with a less evident peridium; the urediniospores of both forms are apparently pedicellate and have a not unusual shape, with colorless walls without well formed echinulation, and with pores that can usually be detected; the teliospores are clustered in the epidermal cells. While all the

spores have rather thin colorless walls, the contents are often colored with the yellow pigment that belongs in the series of characteristic rust colors. Altogether the genus *Hyalopsora* is similar in its main features to *Uredinopsis,* but in all its stages shows an advance in the production of rust characters.

The third best known genus of fern rusts is *Milesia,* with about the same number of species as in each of the other two genera, all being on members of the *Polypodiaceae.* The aecia of one species are known, and occur on *Abies.* In all respects this genus shows some advance in characteristic rust features over *Hyalopsora,* and especially in having only one form of urediniospore.

A fourth genus, *Calidion,* also occurs on *Polypodiaceae,* but only two species are known and of these only the uredinial stage has been seen. The uredinia, however, are wholly unlike those of the other genera, for instead of being subepidermal, they are above the epidermis, surrounded by strongly incurved paraphyses, the whole sorus having been exserted through a stoma.

So much for what we may call one group of fern rusts, and the one containing the presumably most primitive known form on *Osmundaceae.* The *Schizaeaceae,* which harbors in large part the second group, may be considered a somewhat more modern family than the other two fern families, and it will not be surprising to find here a different style of rusts. Only two genera are known. One of these is a strikingly primitive genus, containing three or four species, one of the species being on *Polypodiaceae,* the others on *Schizaeaceae.* The teliospores for one of the species only have yet been found. The genus, *i.e., Desmella,* is of recent discovery, being established by Sydow (Ann. Myc. **16**: 242) in 1918. The whole life cycle is not yet made out, but one may surmise that it is heteroecious, and that the aecia occur upon angiospermous rather than upon coniferous hosts. The uredinia are noticeably echinulate, and are borne on pedicels that protrude through the stomata in tufts, but without paraphyses. The teliospores are in the same way borne on pedicels protruding through the stomata. The latter are smooth, two-celled by a transverse septum, and germinate without a resting stage. Both kinds of spores have somewhat colored walls and contents. One can not refrain from as-

suming that here we have a very primitive form of the great group of *Puccinia*-like rusts.

The last rust on ferns to be mentioned is a species from Brazil on the climbing fern, *Lygodium,* a fern genus belonging to the *Schizaeaceae* of geologically recent origin. This species of rust is in every way similar to the usual conception of a *Puccinia,* and as it is probably heteroecious may be placed in the genus *Dicaeoma.* Both the uredinia and telia are in compact sori and subepidermal, aecia being unknown. The teliospores resemble those of *Desmella,* but are more strongly developed.

The evidence here brought forward, deduced from six genera and nearly forty species, seems strongly to support the view that the fern rusts taken together show primitive characteristics, and that primitive rusts, so far as we can judge of them from existing species, were long cycled, with many spore forms, and found their support upon two groups of unrelated hosts. How long such a condition existed before the full complement of spore forms and the saltation of hosts were reduced there is now no way of deciding, as fossil evidence is not available.

We may undertake to fit the six genera of fern rusts into series in which they will stand at the head of gradually expanding groups. It is easy to see that four of the genera of rusts on *Osmundaceae* and *Polypodiaceae* are to be taken as primitive forms of the family *Melampsoraceae,* and that the two remaining genera on *Schizaeaceae* and *Polypodiaceae* as primitive forms of the family *Pucciniaceae.* We may go farther and assume that *Uredinopsis* has been the precursor of *Pucciniastrum, Melampsorella,* etc., and that *Calidion,* as suggested by Dietel, is in line with the slightly known genus *Olivea.* It is even possible that *Desmella* is an early representative of *Hemileia,* or more likely of some other of the similar outlying *Puccinia*-like forms with superficial sori, and there can scarcely be a doubt that the fern *Dicaeoma* is an early representative of the numerous modern forms of *Dicaeoma.* But altogether too many gaps occur to enable us to go far in tracing a course of development that would string together any considerable number of the present rust genera. When aecia are discovered for the three imperfectly known genera of fern rusts, much more

light will doubtless be shed on the question of descent. It is enough for the present, if the evidence shows the most probable direction in which rust development has taken place, that is, from the complex to the simple, from long cycled kinds with spores of diverse forms to short cycled kinds with a single form of spore in addition to the basidiospore.

PURDUE UNIVERSITY,
LAFAYETTE, IND.

NOTES AND BRIEF ARTICLES

(Unsigned notes are by the editor)

Dr. John T. Buchholz, professor of botany in the State University of Arkansas, spent a part of July and August at Cold Spring Harbor and the New York Botanical Garden in connection with his work on pollination and plant breeding.

Mr. Rafael Menendez Ramos, director of the experiment station at Rio Piedras, Porto Rico, recently spent a day at the Garden. He is especially concerned with the mosaic disease of sugar cane which is doing an increasing amount of damage in the sugar-growing sections of the West Indies.

Professor F. D. Kern of Pennsylvania State College and Professor H. H. Whetzel have recently returned from Porto Rico with an extensive collection of fungi for critical examination. They have been making a special study of the rusts of the island which group they are working in connection with the Flora of Porto Rico which is being published by the New York Academy of Sciences.

Under the title "*Petrakiella* Syd., eine neue Gattung aus der Verwantschaft der Diaportheen," a new species, *Petrakiella insignis,* is described and illustrated by H. Sydow (Ann. Myc. **22**: 230–234) from material collected in southern Brazil by Theissen.

"Beitrag zur Kenntnis der Gattung *Cylindrosporium* Grev." (Ann. Myc. **22**: 191–203, 1924) by von Hohnel contains notes on a number of American species and the new genera *Phloeosporella* (type *Cylindrosporium Ceanothi* Ellis & Ev.) and *Phloeosporina* (type *Cylindrosporium minor* Ellis & Kellerm.).

In "Mykologische Notizen" (Ann. Myc. 22: 1–182) Petrak has described the following new species and genera of fungi from America: *Amphisphaeria portoricensis* n. sp., *Pseudodimerium* n. gen., *Pseudodimerium meliolicolum* n. sp., *Thaxteriella* n. gen., *Thaxteriella corticola* n. sp., *Sphaerophoma* n. gen., *Sphaerophoma Brencklei* n. sp., *Davisiella* n. gen., based on *Cytodiplospora elymina* Davis, *Camarosporium asterinum* n. sp., *Hendersonia panicicola* n. sp., *Clypeoporthella* n. gen., *Clypeoporthella Brencklei* n. sp., *Phomopsis Brencklei* n. sp., and *Shearia* n. gen., based on *Camarosporium Magnoliae* Shear.

The frequent rains in May and June followed by warm weather toward the end of June brought out an unusually large crop of fleshy fungi on lawns and cultivated ground. *Naucoria semiorbicularis* was never more abundant. A specimen of *Stropharia melanosperma* was picked by me in front of the Museum Building on June 28 and the first plants of *Agaricus campester* were noticed the following day. In the woods, a yellow species of *Russula* was fairly common. Three weeks previous, I had collected *Cortinellus rutilans* at Hartsdale; but on June 29 in the Hemlock Grove I found the largest specimens I ever saw of this beautiful mushroom, which measured 15 cm. across and had a stipe 10 cm. in length and 2.5 to 3 cm. thick. Some distance away, I thought I had discovered *Melanoleuca Russula*.

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MYCOLOGIA

VOL. XVI NOVEMBER, 1924 No. 6

NOTES ON THE SCALY SPECIES OF HYDNACEAE

H. C. BEARDSLEE

(WITH PLATE 20)

Students of our Hydnaceae have frequently emphasized the need of more complete field notes upon our American species. Banker, in his revision of the North American Hydnaceae, speaks repeatedly of the lack of definite field notes in regard to our species and the resultant uncertainty in regard to the status of some of them.

As a rule our species are quite rare, Banker for example having been able in six years careful watching to find but two specimens of *Sarcodon imbricatus*. In my collecting grounds at Asheville, North Carolina, on the contrary, they occur at times in abundance, giving ample opportunity for study. Some of my observations made there upon the scaly species of Hydnaceae seem to explain some of the difficulties with this group and for that reason to merit publication.

The most abundant Asheville species is the one commonly referred to *Sarcodon imbricatus* (L.) Karst., though considered by some rather *Sarcodon subsquamosus*. This was regularly found in August and early September, and aside from the growth changes mentioned below, was quite constant. Its appearance is well shown in Fig. 1. The fleshy pileus was light-grayish-brown to dark-brown, with conspicuous, superficial, floccose scales which were larger and more prominent at the center. Along with this typical form were found also other forms which from the circumstances of their growth were taken for older forms of the same

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species. These were, however, so different in their appearance that Lloyd, who saw photographs and specimens, did not think it possible that they could belong to the same species. It became evident that it would be of value to determine the growth changes of the species in order to fix the status of these aberrant forms.

The following season a group of three plants was selected for study. They were in the woods very close to my laboratory so that they could be marked and visited at frequent intervals. The three plants were typical, and with a slight difference in the length of the stipe were practically alike.

One of these plants was collected and photographed with the result shown in Fig. 1. The other two were left undisturbed and visited at intervals of two or three days throughout their growing season. The period of growth proved longer than had been anticipated, being about three weeks before the cycle of growth was completed. During this time the remaining plants changed so as to be almost unrecognizable. The scales soon disappeared. This had been anticipated, as they are clearly superficial, and can easily be removed without serious injury to the surface of the cap. Ten days removed the last traces of the scales in the two plants observed, though it developed later that in rainy weather they are lost more quickly. Along with this change a second change was taking place in the teeth. In the young plant these were from one to ten mm. long, exactly as Banker describes them. With age they became much longer and coarser, reaching, at the end, a length of 25 mm., giving the plants a very shaggy appearance. A third change was entirely unexpected. It will be noted from a careful examination of Fig. 1 that the appearance of the cap indicates a somewhat looser structure at the center. This became very marked with age. The loose tissue soon began to disappear, forming a hollow at the center which gradually extended to the base of the stipe, giving the plant an infundibuliform appearance. These changes brought the two plants into absolute agreement with the aberrant forms collected before and established them as simply old forms of *Sarcodon imbricatus*. Fig. 2 will make these changes clear and indicate the marked difference in their appearance.

These facts seem to explain some of our difficulties in regard to this species. It becomes clear that our descriptions should be extended to make it clear that the scales of this species, which have been taken as diagnostic, are only a phase of the young plant, and that entirely smooth, infundibuliform specimens with unusually long teeth are to be expected. It also becomes apparent that much of our so-called *Sarcodon laevigatus,* differing from *Sarcodon imbricatus* in its smooth pileus, may well be *Sarcodon imbricatus* in which rain or age has removed the scales. Banker in his discussion of the specimens of *Sarcodon laevigatus* which he had examined says, "The plants of the quoted collections vary greatly among themselves. They agree in being large, short-stemmed, with broad pilei, coarse teeth, and brown color. A puzzling fact in connection with them is that the collectors themselves refer their specimens frequently to *Sarcodon subsquamosus* or even to *Sarcodon imbricatus* indicating that, at least in the fresh state, the pileus shows some indications of scales, but there are no signs of scales in the dried specimens." One specimen of my own collection in the set discussed seems certainly in the light of later observations to be *Sarcodon imbricatus,* and the clear statement in regard to them would seem to create a strong suspicion that this is true of the remainder.

The other scaly species which was abundant at Asheville was *Sarcodon fennicus,* as Banker and Lloyd understand that species. One European authority to whom specimens and photos were submitted considered it rather *Sarcodon fuliginco-violaceus* (Kalch.) Quél. which name was used in the treatment of the Hydnaceae of North Carolina. As will be indicated below, I have since found an entirely different plant farther south which seems clearly this species indicating that the North Carolina plant should be considered *Sarcodon fennicus.* In maturity this species is well marked. The scales are not superficial and floccose, but are formed by the surface of the pileus breaking into small triangles, whose points become somewhat reflexed, as will be seen from Fig. 3. The teeth are very short and crowded, and the base of the stipe has a peculiar greenish-blue stain, and the plant has a strong, rather unpleasant odor and bitter taste.

The growth changes of this species are in a way the reverse of the other scaly species. The young plant is entirely smooth, the scales being a later phase. Also the greenish color of the stipe is either entirely lacking or inconspicuous at first.

These young forms answer in every way to the requirements of *Sarcodon Underwoodii* Banker, which seems on this account to need further study and field observation to fix its status.

It remains only to speak of *Sarcodon fuligineo-violaceus.* During the winter of 1920 a plant was observed several times at New Smyrna, Florida, which seems clearly this species, as Lloyd and Banker understand it. The specimens found were smaller than its relative *Sarcodon fennicus,* with a shorter and thicker stipe. The pileus was brown with a faint violaceous tint, while the short crowded teeth in the young plant were beautifully violaceous. The pileus was somewhat pubescent, but smooth or with a few slight innate scales. It is very distinct and when seen growing would at once be distinguished from its relative. This seems to be Kalchbrenner's species and will be easily recognized from the figure.

PERRY, OHIO.

EXPLANATION OF PLATE 20

Fig. 1. *Sarcodon imbricatus* (L.) Karst.
Fig. 2. *Sarcodon imbricatus,* older form showing hollow stipe and smooth pileus.
Fig. 3. *Sarcodon fennicus* Karst.
Fig. 4. *Sarcodon fuligineo-violaceus* (Kalch.) Quél.

Species of Sarcodon

FACTORS INFLUENCING THE INFECTION OF WHEAT BY TILLETIA TRITICI AND TILLETIA LAEVIS [1]

JAMES A. FARIS

The relation of environmental factors to losses from wheat bunt has long been a matter of observation and experiment. With few exceptions, the experimental work has been carried out with field plantings where the groups of factors influencing infection could neither be isolated nor controlled. The limited number of controlled experiments dealing with the influence of environmental factors in the development of bunt have been largely upon *Tilletia Tritici* (Bjerk.) Wint. Very little is known concerning the temperature relations of *Tilletia laevis* Kühn, except what is inferred from temperature and rainfall records during field plantings. Not all authors have stated with which of these species of *Tilletia* they were working, and hence some of the results are of uncertain application.

There seems to be pretty general agreement that low soil temperatures are most favorable for infection by *Tilletia Tritici*. While Tubeuf (**19, 20**) believed that high temperatures promote bunt production, Volkart (**21**) concluded that lower soil temperatures favor the bunt. Hecke (**6**) found, with some exceptions, that early sowings of spring wheat gave higher percentages of bunt than late plantings. Munerati (**9**) obtained 92–100 per cent of bunt in wheat germinated at 7–8° C., while the same varieties gave 1.4–12 per cent when germinated at 18–20° C. In a more recent paper (**10**) he finds that seed germinated at 10–12° C. gave 13.2–39.3 per cent infection while the same two varieties gave 0–1.4 per cent bunt when germinated at 22–25° C. Heuser (**7**) secured 67.1–94.7 per cent bunt in three varieties germinated at 6–10° C. but only 1.8–6 when they were germinated at 16–22° C. Hungerford (**8**) secured higher infections in each of four moisture experiments at 9–12° C. than at 17–25° or 25–28°.

[1] Brooklyn Botanic Garden Contributions No. 41.

Since little is known of the temperature relations of *Tilletia laevis,* experiments were undertaken to germinate inoculated seed under controlled conditions in order to determine the influence of certain soil factors upon infection by this fungus. Similar experiments were carried out with *T. Tritici* in order to learn whether one or the other species was being more favored at any of the various moistures, temperatures, etc. If such proved to be the case it might suggest an explanation of why *T. Tritici* is more generally distributed throughout cooler regions than is *T. laevis.*

In view of the opinion held by many workers that the wheat which is slower in germination is more susceptible to infection by the bunt fungi, and of the recent results reported by Reed and Faris (**16**) which indicate that higher infection is not correlated with slow germination of different varieties in the smuts of oats and sorghum, a series of experiments was undertaken to determine whether or not the seeds within a variety which germinate slower are more heavily infected.

A further interesting problem was to determine whether there exists in either of these bunt fungi well defined biologic forms, such as I have recently shown to occur in the covered smut of barley (**4**) and as Reed (**13**) finds in the smuts of oats.

PART 1. SOIL FACTORS INFLUENCING INFECTION OF WHEAT BY BUNT FUNGI

A. RESULTS WITH WINTER WHEAT

Series I. The Influence of Temperature upon the Infection of Two Varieties of Winter Wheat by Tilletia Tritici and Tilletia laevis

In order to determine the influence of temperature upon the infection of winter wheat by *Tilletia Tritici* (Bjerk.) Wint. and *T. laevis* Kühn, two varieties of wheat were germinated in constant temperature tanks in the fall of 1923 and kept there until the seedlings had produced the second green leaf. They were then transplanted to the field where they were matured the following summer. The general methods of handling these temperature tank experiments were the same as those reported in a previous

paper (3). The seeds of the two wheat varieties, while apparently free from bunt, were treated with hot water as a precautionary measure. The two smut collections were made in July, 1923, the *Tilletia Tritici* coming from near Geneva, N. Y., and the *T. laevis* from the New York Agricultural Experiment Station at Ithaca, N. Y. The former occurred upon Dawson wheat, and the latter upon a variety known as Ontario Agricultural College No. 104. Therefore, these two varieties were chosen as hosts in the temperature experiments. I am obligated to Prof. H. H. Love of Cornell University for supplying seed of these varieties.

Plantings of both varieties inoculated with the spores of each smut were made in a potting soil testing pH 7 and having a moisture content of 61.9 per cent of its water holding capacity. Germination tests of the smut spores were made but the percentages were not determined because of the difficulty of culturing bunt spores in such a way that accurate counts could be made. The germination tests were made by sprinkling the spores upon moist earth in petri dishes and incubating them in the ice box. *Tilletia laevis* germinated very well but *T. Tritici* germinated rather feebly. The results of this series of experiments are given in Table I and summarized in the graphs of Fig. 1.

TABLE I

THE INFLUENCE OF TEMPERATURE UPON INFECTION OF DAWSON AND ONTARIO AGRICULTURAL COLLEGE NO. 104 WINTER WHEATS BY *Tilletia laevis* AND *Tilletia Tritici*

Variety	Temp.	*Tilletia Tritici*				*Tilletia laevis*			
		Total number plants	Number smutted	Number partially smutted	Per cent infected	Total number plants	Number smutted	Number partially smutted	Per cent infected
Dawson (Honor).	5° C.	45	2	4	13.3	53	17	20	69.8
	10° C.	51	1	6	13.7	65	17	25	64.6
	15° C.	67	0	4	5.9	65	23	12	53.8
	20° C.	51	0	0	—	58	3	6	15.5
	25° C.	59	0	0	—	48	0	0	—
	30° C.	56	0	0	—	56	0	1	1.7
O. A. C. No. 104.	5° C.	46	1	0	2.1	42	12	15	64.2
	10° C.	56	1	4	8.9	64	18	21	60.9
	15° C.	58	1	0	1.7	52	15	14	55.7
	20° C.	57	0	0	—	61	5	5	16.3
	25° C.	58	0	0	—	54	0	1	1.8
	30° C.	59	0	0	—	59	0	0	—

The Results with Tilletia laevis.—The infections were highest at the lowest temperature in both varieties when the seed had been inoculated with *T. laevis*. There was a slight falling off at 10° C., a further drop at 15° C., but the infection percentages were still very high. From 5° C. to 15° C. the temperatures are well within the range of high infection. At 20° C. we have a marked drop which continues at 25° C. until the zero point is reached in one

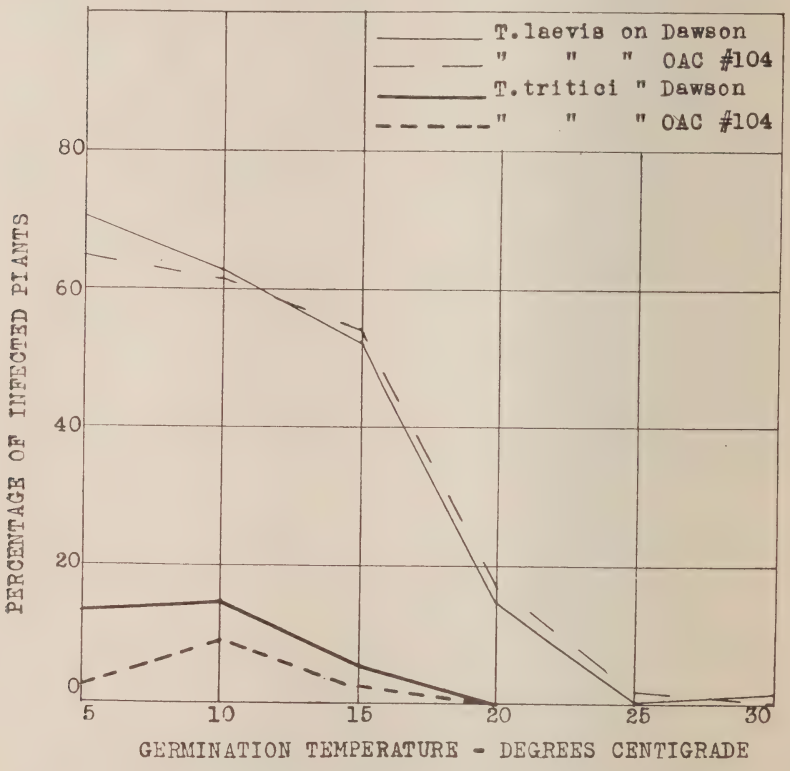

FIG. 1. Graph showing the influence of temperature upon infection of Dawson and O. A. C. No. 104 winter wheat by *Tilletia laevis* and *T. Tritici*.

variety and almost reached in the other. At 25° C. one plant of O. A. C. No. 104 was partially smutted and at 30° C. one plant of Dawson became partially infected.

The curves for the two varieties (Fig. 1) are remarkably close together throughout the entire temperature range, thus the infection results of each variety check those secured for the other.

Results with Tilletia Tritici.—The infections secured with *Tilletia Tritici* are far lower than could reasonably be expected and for this reason it seems that some other condition than temperature determined whether or not the disease developed. It should be noted, however, that such smut as occurred indicates that with these two varieties slightly more disease occurred at 10° C. than at 5° C. The infections are so low that no general conclusion should be drawn. No infections occurred at 20°, 25° or 30° with this species. I am at a loss to explain these low infections with *T. Tritici,* as the inoculum was collected and handled exactly the same as the *T. laevis.* It may be, however, that the low infections secured with this collection of smut were due to poor spore germination. It should be noted, however, that the smutted heads of *T. Tritici* collected in the field appeared to be less than half the height of the sound heads in the same field. The marked shortness of the diseased stalks observed in collecting this smut in the field was not apparent in the diseased plants in these experiments. In fact, the culms with smutted heads varied from a few inches to the full height of the sound plants.

Series II. The Influence of Soil Moisture and the Character of the Substrata upon Infection

In this series of experiments seed of the same two varieties of wheat used in series I were germinated in the temperature tanks, from which they were transplanted to the field upon the appearance of the second leaf. Two substrata were used—a potting soil and a pure quartz sand. In the soil experiments two moistures were used, *i.e.,* 30 and 61.9 per cent of the moisture holding capacity based upon the oven dry weight. Three moisture contents (10, 45, and 80 per cent) were used with the quartz sand. All seed were germinated in the temperature tanks at a temperature which varied somewhat, the first two days it was held at 14° C., then one day at 12° C. from which it was lowered to 10° C. until the seedlings were transplanted. All seeds were planted at the same time but those at the lowest moistures germinated so slowly that they were not transferred to the field until three days after the seedlings produced at the higher moistures. Smuts from the

same two collections of series I were used in these experiments. The results are recorded in Table II.

TABLE II

THE INFLUENCE OF THE SOIL MOISTURE AND THE CHARACTER OF THE SUBSTRATA DURING GERMINATION UPON INFECTION OF WINTER WHEAT BY *Tilletia Tritici* AND *Tilletia laevis*

Variety	Substrata	Per cent moisture	*Tilletia Tritici*				*Tilletia laevis*			
			Number plants	Number smutted	Number partially smutted	Per cent infected	Number plants	Number smutted	Number partially smutted	Per cent infected
Dawson.....	Quartz sand	10	49	0	0	—	41	11	7	43.9
		45	52	0	0	—	46	10	11	45.6
		80	54	1	1	3.7	47	13	16	61.7
Dawson.....	Potting soil	30	50	2	2	8.0	49	26	4	61.2
		61.9	47	1	0	2.1	52	30	15	86.5
O. A. C. No. 104...	Quartz sand	10	40	0	3	7.5	33	18	3	63.6
		45	46	1	0	2.2	42	18	14	76.2
		80	53	0	1	1.9	45	22	8	66.6
O. A. C. No. 104...	Potting soil	30	52	0	1	1.9	46	34	3	80.4
		61.9	51	0	2	3.9	52	32	4	69.2

Results with Tilletia laevis.—In both varieties the seed germinated in soil gave higher infection than did that germinated in quartz sand. The infections at all moistures in both soil and sand are sufficiently high to demonstrate that neither the soil moisture content nor the character of the substrata here used have very narrow limits of infection under the conditions of these experiments. It should be pointed out, however, that these seedlings were germinated in covered glass jars, and hence in an atmosphere of very high humidity. It would seem that just such conditions might prevail in this climate when wheat is planted.

Results with Tilletia Tritici.—Again the infections with this species were very low and no conclusions can be drawn from the results obtained.

Series III. The Influence of Date of Planting upon Infection

For this experiment two plantings were made, using the same two varieties of series I and II, as well as the same two species of

the fungus. The seed was inoculated with powdered spores and planted in the experiment field. The first planting was made October 9, and the second October 25, 1923. The results are recorded in Table III.

TABLE III

INFLUENCE OF DATE OF PLANTING IN THE FIELD UPON INFECTION OF TWO VARIETIES OF WINTER WHEAT BY *Tilletia laevis* AND *Tilletia Tritici*

Variety	Date planted	*Tilletia Tritici*				*Tilletia laevis*			
		Number plants	Number smutted	Number partially smutted	Per cent infected	Number plants	Number smutted	Number partially smutted	Per cent infected
Dawson.....	Oct. 9, 1923	77	1	5	7.8	49	31	2	67.3
Dawson.....	" 25, "	29	1	0	3.4	37	22	1	62.2
O. A. C. No. 104...	Oct. 9, "	99	2	1	3.0	44	29	5	77.3
O. A. C. No. 104...	" 25, "	26	0	0	—	31	22	3	80.6

Results with Tilletia laevis.—The plantings gave fairly high infection for field sowing on both dates. In one variety (Dawson) higher infection was secured in the planting of October 9, while in the other variety a higher percentage of the plants were diseased in the plantings of October 25. These variations are less than five per cent in either case and are as close as could be expected under the conditions of field planting. The soil temperatures ranged between 18° C. and 5° C. throughout the period from October 9 to November 5, but the temperatures were very much the same for the first seven days after each planting, being around 12° C. for the planting of October 9 and 10° C. for that of October 25.

B. RESULTS WITH SPRING SOWN WHEAT

A number of American investigators (5) have experienced difficulty in securing bunt infections in wheat seeded in the spring. However, Hecke (6) and Munerati (9, 10), working in Europe, report satisfactory bunt infections in wheat planted in the spring. In order to determine whether any marked differences occurred in results secured with winter wheat germinated under controlled

conditions and matured in the field and infections secured by germinating inoculated seed of both winter and spring wheat under controlled conditions in the spring and maturing them in the field, the following series of experiments were carried out.

Series IV. The Influence of Temperature upon the Infection of Dawson, Marquis, and Red Fife Wheat by Tilletia laevis and Tilletia Tritici

One variety of winter wheat (Dawson) and two spring wheat varieties (Marquis and Red Fife) were inoculated with the spores of two collections of each of the two species of bunt fungi. These

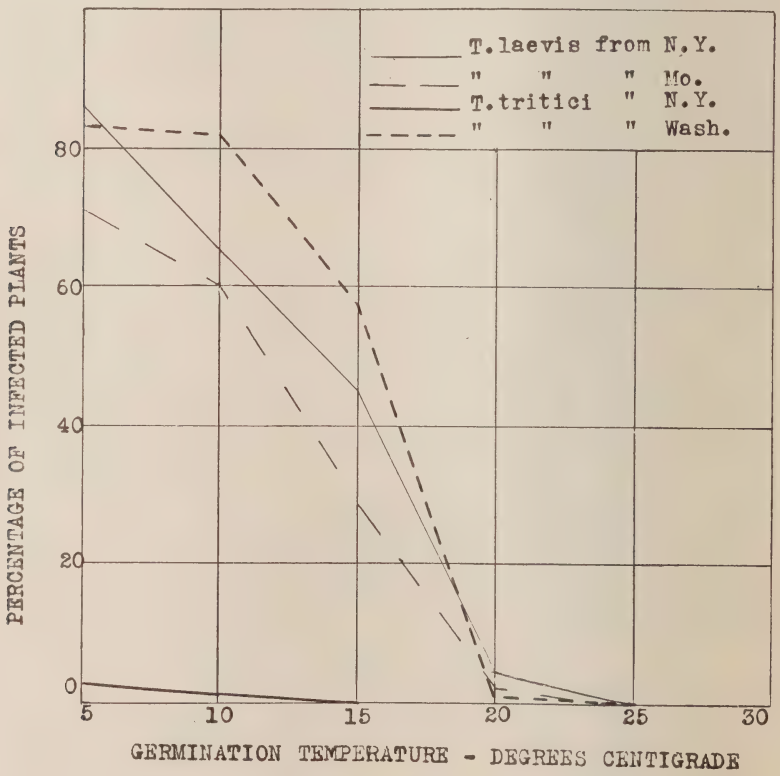

FIG. 2. Graph showing the influence of temperature upon the infection of Dawson winter wheat by *Tilletia laevis* and *T. Tritici*

three varieties, each inoculated with four smut collections, were germinated in a potting soil testing pH 7, with a moisture content

TABLE IV

THE INFLUENCE OF TEMPERATURE UPON THE INFECTION OF DAWSON, MARQUIS, AND RED FIFE WHEAT BY *Tilletia laevis* AND *Tilletia Tritici*

Variety	Germination temperature ° C.	*Tilletia Tritici*								*Tilletia laevis*							
		Smut from New York				Smut from Washington				Smut from New York				Smut from Missouri			
		Total plants	Number smutted	Number partially smutted	Per cent infected	Total plants	Number smutted	Number partially smutted	Per cent infected	Total plants	Number smutted	Number partially smutted	Per cent infected	Total plants	Number smutted	Number partially smutted	Per cent infected
Dawson.....	5	60	2	0	3.3	55	14	32	83.6	49	15	27	85.9	70	32	18	71.4
	10	68	0	1	1.5	61	33	17	81.9	63	28	13	65.1	63	27	11	60.3
	15	75	0	0	—	73	35	7	57.5	79	21	15	45.6	83	16	8	28.9
	20	78	0	0	—	78	1	0	1.3	80	2	2	5.0	84	2	0	2.4
	25	60	0	0	—	58	0	0	—	66	0	0	—	50	0	0	—
	30	61	0	0	—	45	0	0	—	45	0	0	—	52	0	0	—
Marquis.....	5	42	0	0	—	44	0	14	31.8	41	0	8	19.5	43	1	8	20.9
	10	71	0	2	2.8	53	8	9	32.1	56	3	20	41.1	68	55	3	85.3
	15	81	0	0	—	79	14	8	27.8	84	9	9	21.4	81	17	2	23.5
	20	74	0	0	—	73	2	0	2.8	72	1	0	1.4	70	2	0	2.9
	25	69	0	0	—	66	0	0	—	65	0	0	—	62	0	0	—
	30	68	0	0	—	66	0	0	—	65	0	0	—	65	0	0	—
Red Fife.....	5	40	0	1	2.5	40	0	18	45.0	45	3	25	62.2	37	12	8	54.1
	10	69	0	0	—	62	19	14	53.2	50	11	11	44.0	52	20	7	51.9
	15	73	0	0	—	75	10	5	20.0	70	10	9	27.1	66	27	1	42.4
	20	71	0	0	—	51	1	1	3.9	68	1	1	2.9	83	2	0	2.4
	25	64	0	0	—	77	0	0	—	55	0	0	—	73	0	0	—
	30	60	0	0	—	52	0	0	—	56	0	1	1.8	47	0	0	—

of 61.9 per cent, in constant temperature tanks at 5°, 10°, 15°, 20°, 25°, and 30° C. After the appearance of the second green leaf the seedlings were transplanted into paper pots, and kept in the greenhouse for a few days until favorable weather for plantings in the experiment field. The results secured are given in Table IV and summarized in the graphs of Figs. 2, 3, and 4.

Results with Dawson Wheat Planted in the Spring.—The infection percentages secured in these experiments with Dawson wheat

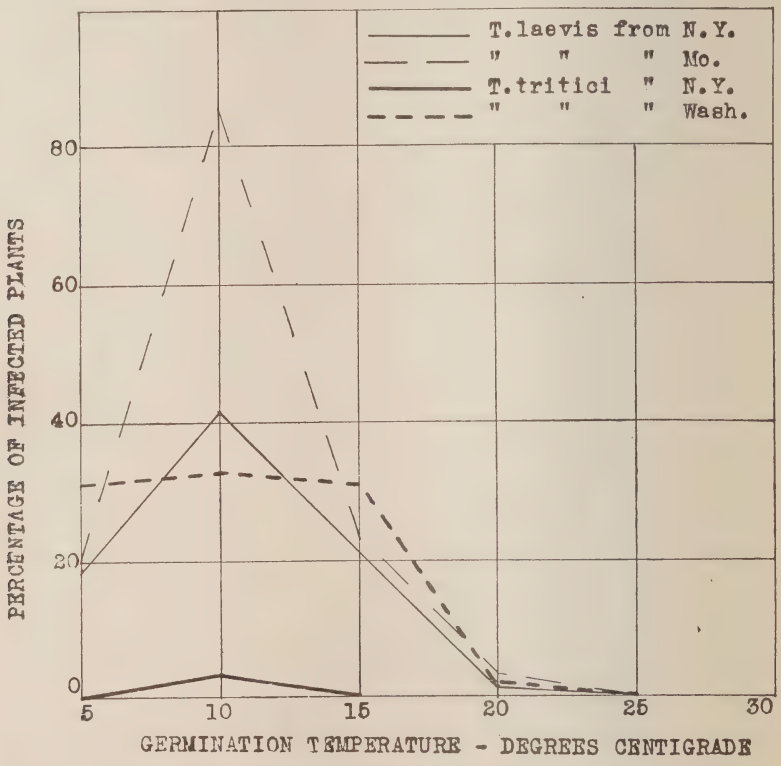

FIG. 3. Graph showing the influence of temperature upon the infection of Marquis wheat by *Tilletia laevis* and *T. Tritici*

inoculated with *T. laevis* from New York are remarkably close to those obtained in the fall planting with another selection of this variety inoculated and germinated under the same soil conditions. (Compare Tables I and IV.) At the two low temperatures, the infections are slightly higher in the spring than in the fall planting,

but are somewhat less at 15° and 20° C. The Missouri collection of *T. laevis* gave slightly lower percentages of infection at 5°, 10°, and 15° C. than did the New York collection. On the other hand, the infections with *T. Tritici* from Washington were higher at 10° and 15° than were those secured with either collection of *T. laevis*. The *T. Tritici* from New York again gave very few diseased plants.

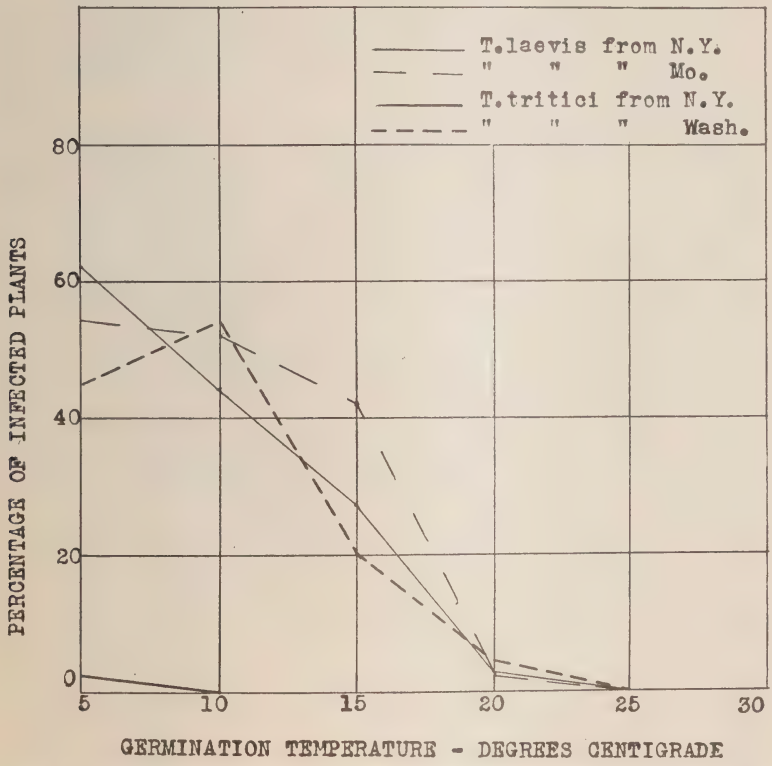

FIG. 4. Graph showing the influence of temperature upon the infection of Red Fife wheat by *Tilletia laevis* and *T. Tritici*

These experiments with winter wheat showed the same deleterious effects of high germination temperatures as I have recorded for Texas winter barley (3). The plants of Dawson from the 5° tank tillered well and matured at the same time as those of Marquis and Red Fife germinated with them at higher temperatures. At higher temperatures the winter variety produced tillers

profusely, but matured very few spikes. Such heads as were produced came a month later than did those of Dawson germinated in the 5° tank or the other spring varieties germinated at the higher temperatures.

Results with Marquis and Red Fife Wheats.—The striking feature of the results with Marquis wheat is that with every smut collection infections were higher at 10° C. than at 5° C. Very high infection was secured with the *T. laevis* from Missouri at 10°.

This marked increase at 10° is followed by a rapid decline in the percentages at 15° and 20° and in no case was there any infection at 25° or 30°.

Red Fife proved to be very susceptible at both low temperatures, the percentages dropping rapidly in all cases except with *Tilletia Tritici* from Washington where there was a small increase of infection at 10° C. followed by a very rapid drop at 15°, 20°, and 25°. One plant of this variety was partially smutted at 30° in the collection of *T. laevis* from New York. In the fall plantings (Table I) one plant was also partially smutted at a germination temperature of 30° C.

PART II. PHYSIOLOGICAL FACTORS INFLUENCING THE INFECTION OF WHEAT BY BUNT FUNGI

Series V. The Influence of Growth Conditions Subsequent to Germination upon the Development of Bunt

In order to determine whether growth conditions after germination influence the amount of bunt in the resultant crop, as has proved to be the case with the covered smut of barley (4), an experiment was carried out in which each of two varieties of winter wheat, inoculated with spores of the New York collections of *T. laevis* and *T. Tritici,* were germinated in the temperature tanks in a good potting soil with a pH reaction of 7 and a moisture content of 61.9 per cent of the moisture holding capacity. The seedlings of each lot were then divided at random, one half being planted in the field, the other half in the greenhouse. Those plants matured in the field passed through the winter freezing conditions as do all fall sown grains in this climate, while the plants matured in the greenhouse made uninterrupted growth from germination until

maturity. This series was germinated at the varied temperatures, simultaneously with series II. The results are given in Table V.

TABLE V

THE INFLUENCE OF GROWTH CONDITIONS SUBSEQUENT TO GERMINATION OF WINTER WHEAT UPON THE DEVELOPMENT OF *Tilletia laevis* AND *Tilletia Tritici*

Variety	Matured in	*Tilletia Tritici*				*Tilletia laevis*			
		Number plants	Number smutted	Number partially smutted	Per cent infected	Number plants	Number smutted	Number partially smutted	Per cent infected
Dawson	Field	47	1	0	2.1	52	30	15	86.5
	Greenhouse	53	3	0	5.6	48	26	2	58.3
O. A. C. No. 104	Field	51	0	2	3.9	52	32	4	69.2
	Greenhouse	61	1	1	3.2	45	32	1	73.3

In so far as these data go there is no evidence that the growth of the host after the germination stages has a marked effect upon the development of bunt in these varieties of winter wheat. When this experiment was begun it seemed that the difficulties of securing infection in field plantings of spring wheat, which some authors have reported (5), might be due to some such factor as the rate of growth, since spring wheat is usually planted at a time when soil moistures and temperatures are well within the ranges for high infection (see Tables I and IV). Contrary to expectations, no wide differences are indicated by the results of this series of experiments. No generalization can be reached, however, until experiments dealing directly with spring wheat, under growth conditions comparable to those where infection difficulties have been experienced, have been carried out.

Series VI. The Influence of Rate of Germination upon the Percentage of Bunt

In recent papers Woolman and Humphrey (22) and Reed (14) have reviewed the literature upon the relation of infection to the varietal characters of prompt germination and growth. It is suf-

ficient here to point out that a number of workers have maintained that resistance is dependent upon quick germination and growth, while others have expressed great doubt that this is the case.

Reed and Faris (16) have recently brought forth data to show that resistance and susceptibility in the case of two sorghum smuts and the covered smut of oats are not correlated to the quickness with which the respective varieties emerge from the soil. Since some seedlings of a given variety emerged from the soil much earlier than did others when all were grown under the same conditions in our temperature tanks, the problem of determining whether a larger or smaller percentage of these early seedlings are infected, than of those which come up later, presented itself.

The remarkable uniformity with which the seedlings of barley emerge from the soil made such an experiment with that host very difficult. On the other hand the seedlings of the Dawson and O. A. C. No. 104 wheat varieties used in series I required five or six days from the time the first shoots began to emerge until all the plants had come up. This seemed suitable material for determining the above point.

The seed was inoculated and planted in a potting soil in the temperature tank as in series I. All seeds were planted a uniform depth of one inch. The seedlings which had emerged the first three days after the plants began to come up were marked with a paper ring and when transplanted these more advanced seedlings were put at one end of the row and the slower ones at the other. In one experiment the seeds were germinated at 5° C. and transplanted to the field and in a second experiment the seeds were germinated at a temperature varied from 14° C. to 10° C., after which one half of the faster and slower germinators of each set were planted in the greenhouse, the other half in the field. The results are given in Table VI.

Results with Tilletia laevis.—In every experiment of this series where either of the wheat varieties was inoculated with *T. laevis* those seedlings which emerged from the soil first were more heavily infected than those which came up later. In the variety Dawson, 84.7 per cent of the plants which came up first were infected while only 47.6 per cent of those which emerged later were

TABLE VI

THE INFLUENCE OF THE RATE OF GERMINATION UPON THE PERCENTAGE OF SMUT

Variety	Germination temperature ° C.	Matured in	Germination soil moisture	*Tilletia Tritici*						*Tilletia laevis*					
				Late seedlings			Early seedlings			Late seedlings			Early seedlings		
				Number plants	Number infected	Per cent infected	Number plants	Number infected	Per cent infected	Number plants	Number infected	Per cent infected	Number plants	Number infected	Per cent infected
Dawson.....	5	Field	60	10	0	0	35	6	17.1	23	14	60.9	30	23	76.7
	14–10	"	30	18	1	5.6	32	3	9.4	22	9	40.9	27	21	77.8
	"	"	60	26	0	0	21	1	4.8	16	10	62.5	36	35	97.2
	"	Greenhouse	60	22	0	0	31	3	9.6	23	7	30.4	25	21	84.0
		Total.....	.....	76	1	1.3	119	13	10.9	84	40	47.6	118	100	84.7
O. A. C. No. 104..	5	Field	60	23	0	0	23	1	4.3	19	7	36.8	23	20	86.9
	14–10	"	30	18	0	0	34	1	2.9	29	21	72.4	17	16	94.1
	"	"	60	23	1	4.3	28	1	3.6	27	12	44.4	25	24	96.0
	"	Greenhouse	60	26	1	3.9	35	1	2.9	20	8	40.0	25	25	100.0
		Total.....	.....	90	2	2.2	120	4	3.3	95	48	50.5	90	85	94.4
Grand total—both varieties.....				166	3	1.8	239	17	7.1	179	88	49.2	208	185	88.9

diseased, a difference of 37.1 per cent. The O. A. C. No. 104 variety gave 50.5 per cent infection in the plants which emerged last while the earlier ones were smutted to the extent of 94.4 per cent, a difference of 43.9 per cent. With two varieties of wheat, germinated under controlled conditions at two soil temperatures, at two soil moistures, and when matured in both greenhouse and field a grand total of 185 plants out of the 208 which emerged first or 88.9 per cent were diseased, while only 88 of the 179 which came up later or 49.2 per cent were diseased. A total of eight comparative experiments with this smut gave higher percentages of infection in every case in the plants which emerged from the soil first.

Results with Tilletia Tritici.—As has been the case in all other experiments where this particular collection of *T. Tritici* was used, the percentages of infection here are very low. With two exceptions, however, the plants which emerged from the soil first were the most severely infected. In the two cases where the percentages are higher in the later seedlings, the number of plants infected is the same in both the earlier and later plants but the percentages are slightly higher in the latter because of the lower total number of plants.

The totals with each variety and the grand totals of both varieties show decidedly more infection in the seedlings which were quicker to emerge from the soil.

Series VII. The Influence of the Source of the Spores upon the Production of Bunt in Winter Wheat

In a recent paper Reed (14) has called attention to the different results secured by various investigators working in widely separated localities, with the same wheat variety and the same fungus species. He suggested the probability that the discrepancies recorded by the different observers may in part be explained upon the basis of specialized races in the species of *Tilletia*.

In light of the finding of biologic forms in the covered smut of barley by the writer (3, 4), and the discovery of specialized races in the oat smuts by Reed (13), as well as the suggestive nature of the above mentioned discrepancies, a limited series of experiments

was carried out to determine whether collections of either of the bunt fungi from widely separated localities would show well defined biologic forms.

Owing to a limited amount of seed, and, in some cases, a small quantity of smutted wheat, only ten varieties of wheat were grown. Twelve collections of smut, six of *Tilletia laevis* and six of *Tilletia Tritici,* were used. In addition to securing a preliminary test with these smut collections, it was hoped that sufficient smutted plants would occur to give inoculum for a much larger number of varieties the following year.

The results of this preliminary test are being given at this time because of the interesting results secured with some of the collections.

All seed was treated with hot water (presoaked 8 hours and then immersed in water at 54° C. for 13 minutes) and after thoroughly dry it was heavily inoculated with spores of the respective fungous collections, all of which had been made the season of 1923 except collection No. V of the *Tilletia laevis* and No. VI of *T. Tritici* which were gathered in 1922.[2]

All varieties were planted in the experiment field October 9th in 5 foot rows. The soil temperature during the period of germination ranged from 8° C. to 17° C. with an average of about 14° C. The soil was rather dry the first three days after planting but was then thoroughly soaked by a heavy rain which was followed by clear dry weather. The infection results are recorded in Tables VII and VIII.

Results with Tilletia laevis.—There are some differences in the amount of infection secured when spores from the various sources were used. Dawson wheat with collection V, Leap Prolific with collection IV and Club with collection III all gave much lower infections than were secured when the same varieties were inoculated with spores from other sources. Furthermore, the smut spores in all collections were viable as is evidenced by the high infections

[2] I am indebted to Dr. G. M. Reed, Curator, Brooklyn Botanic Garden, for supplying me with all smut collections except Nos. II and IV of *Tilletia laevis* and IV and V of *T. Tritici,* and for the seed of Kanred, Club, Red Rock, Poole, Mealy, Leap Prolific, and Fulcaster, and to Prof. H. H. Love of Cornell University for the other three varieties of wheat.

secured on some of the varieties with spores from each collection. It is quite likely that in an experiment with more varieties some would differentiate more sharply between these smut collections.

TABLE VII

THE PERCENTAGES OF INFECTION OF TEN WINTER WHEAT VARIETIES BY SIX COLLECTIONS OF *Tilletia laevis* KÜHN

Wheat variety	*Tilletia laevis* collection											
	No. I		No. II		No. III		No. IV		No. V		No. VI	
	Number plants	Per cent infected	Number plants	Per cent infected	Number plants	Per cent infected	Number plants	Per cent infected	Number plants	Per cent infected	Number plants	Per cent infected
Dawson (Honor)	51	49.2	54	70.4	48	54.2	49	67.3	45	17.1	48	75.0
Fulcaster	74	75.7	72	77.8	66	59.1	63	71.4	63	69.9	89	76.4
Junior No. 6	55	50.9	54	55.6	54	27.8	56	44.6	56	41.1	80	62.5
Leap Prolific	17	41.2	17	64.7	15	53.3	17	17.6	16	62.5	26	61.5
Mealy	95	74.7	122	69.7	122	64.8	97	72.2	102	64.7	81	87.6
O. A. C. No. 104	48	60.4	47	72.3	49	47.8	44	77.3	49	57.1	38	68.4
Poole	87	49.4	70	72.8	88	50.0	84	82.1	70	52.9	83	74.7
Red Rock	51	39.2	22	72.7	33	27.3	28	32.1	27	51.9	66	51.5
Club	66	33.3	57	24.6	63	9.5	50	28.0	56	25.0	35	37.1
Kanred	38	39.5	—	—	—	—	36	50.0	—	—	—	—

TABLE VIII

THE PERCENTAGES OF INFECTION OF TEN WINTER WHEAT VARIETIES BY SIX COLLECTIONS OF *Tilletia Tritici* (BJERK.) WINTER

Wheat variety	*Tilletia Tritici* collection											
	No. I		No. II		No. III		No. IV		No. V		No. VI	
	Number plants	Per cent infected	Number plants	Per cent infected	Number plants	Per cent infected	Number plants	Per cent infected	Number plants	Per cent infected	Number plants	Per cent infected
Dawson (Honor)	49	71.4	41	75.6	56	75.0	43	13.9	44	0	48	37.5
Fulcaster	71	90.1	62	79.0	63	73.0	66	6.0	64	4.7	67	56.9
Junior No. 6	59	66.1	65	78.5	51	52.9	67	0.0	66	0.0	65	27.7
Leap Prolific	14	71.4	19	68.4	25	64.0	25	4.0	32	0.0	22	45.4
Mealy	116	68.1	93	87.1	82	54.9	84	0.0	75	0.0	104	88.5
O. A. C. No. 104	46	80.4	38	76.3	47	68.1	57	5.3	42	0.0	46	63.0
Poole	67	76.1	68	75.0	56	76.8	54	1.9	62	1.6	79	72.2
Red Rock	14	78.6	15	66.7	25	80.0	38	0.0	33	0.0	33	30.3
Club	58	29.3	43	69.8	70	52.9	61	4.9	86	3.4	51	1.8
Kanred	36	38.8	36	86.1	43	76.7	38	0.0	39	0.0	34	0.0

The present data are suggestive but further work is necessary before the true nature of these differences can be ascertained.

Results with Tilletia Tritici.—Very satisfactory infections were secured with collections I, II, III and VI of this species. The high infections secured with some variety with each of these four collections of spores make it quite certain that any infection differences shown by them are not due to a lack of viable spores. With collections IV and V, however, this is not the case and failure to get high infection in any variety may mean that for some reason the spores had lost their ability to infect any host. These two collections were made in the summer of 1923 at the same time the New York *Tilletia Tritici* used in the experiments of series I and II was collected. My entire season's results with these collections have been unsatisfactory. Care has been taken to preserve smutted heads for further study to learn whether this lack of satisfactory infections is due to some storage condition, or whether the wheat varieties used are resistant to these two smut collections.

Very interesting indeed are the infections secured with Club and Kanred wheats when inoculated with spores of the first three collections as compared with the amount of disease obtained when the spores of collection VI were used as inoculum. The spores of the latter collection were viable as is evidenced by the fact that the variety Mealy gave 88.5 per cent infection. Therefore, it would seem that the small percentage of diseased plants of Club wheat, and complete lack of infection in Kanred, are due to a certain amount of resistance on the part of these two varieties to this particular smut collection. In light of the results secured in the temperature and moisture experiments, there seems to be no reason to believe that this lack of infection is due to any sharp environal factor. Furthermore, high infections were secured with other varieties on both sides of these rows. On the other hand, both Club and Kanred were very susceptible to collections I, II and III. The Club wheat gave 29.3, 69.8 and 52.9 and Kanred gave 38.8, 86.1 and 76.7 per cents of infection with those three respective smut collections. There seems little reason to doubt that we are here dealing with specific differences in the ability of the spores in these collections to infect these two varieties. These data, while

not exhaustive, are clear cut and in light of the infection percentages secured by Stephens and Woolman (18) at Moro and Corvallis, Oregon, which indicate that Kanred is resistant to *Tilletia Tritici,* it seems quite likely that these results are representative of what would happen in more extensive experiments.

DISCUSSION AND CONCLUSIONS

SOIL FACTORS INFLUENCING INFECTION

The soil temperature during the period of germination has proven to be the most important factor in the infection of Dawson and O. A. C. No. 104 winter wheat by *Tilletia laevis.* The character of the substrata and the percentage of moisture in both soil and sand did not closely limit the amount of infections secured in series II. The importance of low soil temperatures during germination is further demonstrated in the tank experiments recorded in Table IV, in which a winter variety and two varieties of spring wheat were germinated in the spring in controlled temperature tanks and matured in the experiment field. In this series of experiments 5° C. proved most favorable for the development of *T. laevis* in Dawson and Red Fife, but 10° C. was more favorable for the development of both *T. Tritici* and *T. laevis* in the variety Marquis.

In two sorghum Kernel smuts Reed and Faris (15) report similar results in that they secured the highest infection in Kaoliang with both *Sphaceloth*eca *Sorghi* and *S. cruenta* and Darso with *S. cruenta* (the only one to which it is susceptible) at 20° C., while Kafir and Sorgo gave higher infections with both smuts at 25° C. than at 20° C. Dickson (1) found that the temperatures most favorable for high infections by the seedling blight fungus (*Gibberella Saubinetii*) of wheat and corn were different for these two host plants. From his results with this organism he concludes that "the influence of the environmental factors on the hosts seems to be the fundamental cause of susceptibility to the disease."

Upon first thought a logical conclusion from our results with sorghum and those with wheat seemed to be that the temperature

was influencing the host since the two species of the respective parasites gave the highest infection at the same temperature when a particular host variety was used, but this temperature for maximum infection was different for the two varieties in each case. However, it seems quite as reasonable to conclude that we have these different points for highest infections in both sorghum and wheat because the varieties are different from the start. That is, it is not necessary to suppose that the treatments rendered the varieties more susceptible at these different temperatures for they may have had this inherent difference to begin with.

I have shown in the covered smut of barley that the point for highest infection may be varied by using soils of different pH reactions, if other factors are kept the same. Reed and Faris (16) found that the optimum temperature for infection in the covered smut of oats could be changed by using different soil moisture contents, other factors being the same. In the above experiments the optimum temperature for infection is varied by using a different variety, all other conditions being the same. Therefore, the optimum soil temperature, moisture and acidity are not fixed, but must be considered in relation to each other; and now we must add in relation to the response of the variety to the interaction of all these, and perhaps other environmental influences.

It is significant to find that the relative susceptibility of two wheat varieties to bunt may be quite different when each is exposed at different temperatures to the same combination of other environal influences. It may well be that some of the fluctuations in infection percentages secured by planting several varieties upon the same date, at various intervals during the season, are due to these different varietal responses to the same combination of conditions, rather than to very localized differences of soil conditions.

The results with *T. Tritici* also indicate that the low germination temperatures are more favorable for high infection. The plants germinated in the 10° C. tanks were more heavily infected in the two varieties planted in the fall, and in the two spring varieties, but the Dawson sown in the spring had a slightly higher percentage of the plants germinated in the 5° C. tank bunted. Both species of these fungi, therefore, find conditions most favor-

able for infection at low soil temperatures, and both seem to have about the same temperature range. A few partially smutted plants were produced in experiments where the seed inoculated with *T. laevis* was germinated at 25° and 30° C. (see Tables I and IV), however, while no smutted plants were secured with the *T. Tritici* at these higher temperatures.

The date of planting experiments give no marked differences in the percentages of infection secured when the varieties were seeded October 9th or 25th. This is the result which would be expected since the soil temperatures during the period of germination were low and hence within the range where fairly constant results may be expected (see Figs. 1 and 4).

PHYSIOLOGICAL FACTORS INFLUENCING INFECTION

Neither the results of the experiments upon the environmental factors nor those upon the influence of growth conditions after the period of infection throw much light upon the reason why it is difficult to secure satisfactory infection in spring wheat as recorded by some authors (5). The possibility that wider extremes of one or more of these factors may explain this situation should not be overlooked.

The results of the experiments upon the rate of germination of seeds within the variety indicate that the more vigorous seedlings are more subject to infection. In this respect bunt of wheat is like the rusts as reported by Stakman (17) and Raines (11, 12), who find that whatever is conducive to the vigorous development of the host is usually conducive to the vigorous development of the parasite, and hence, unlike the seedling blight organism (*Gibberella Saubinetii* (Mont.) Sacc.) of wheat and corn, as reported by Dickson, Eckerson, and Link (2) who find "that conditions of environment, which are unfavorable for the best development of the cereal seedling, predispose it to attack by the fungus."

There is considerable evidence that we have a fundamental difference between those fungi, which are strictly parasitic, such as the smuts and rusts, and those which are semi-saprophytic, as is *Gibberella Saubinetii*, in that the former group requires vigorously growing host plants for its best development, while the latter class

finds conditions more favorable when the host plant is somewhat weakened.

The evidence presented in Tables VII and VIII, which indicates that different collections of both *T. laevis* and *T. Tritici* may give quite different percentages of infection when seed lots of a variety are inoculated with spores of the various collections and grown under comparable conditions, indicates that these bunt species are specialized into races, as suggested by Reed (14).

The scientific and economic importance of wheat bunt justifies a much more complete study of the infection capabilities of a large number of spore collections upon a considerable number of wheat varieties. It is no longer sufficient to assume that results secured with one spore collection represent what would happen were other collections of the same bunt species used.

LITERATURE CITED

1. **Dickson, James G.** Influence of soil temperature and moisture on the development of the seedling blight of wheat and corn caused by *Gibberella Saubinetii*. Jour. Agr. Research 23: 837–870. 1923.
2. **Dickson, James G., Eckerson, Sophia H. & Link, Karl P.** The nature of resistance to seedling blight of cereals. Proc. Nat. Acad. Sci. 9: 434–440. 1923.
3. **Faris, James A.** Factors influencing the infection of *Hordeum sativum* by *Ustilago Hordei*. Am. Jour. Bot. 11: 189–214. 1924.
4. ——. Physiological specialization of *Ustilago Hordei*. Phytopathology 14: in press. 1924.
5. **Güssow, H. T.** Smut diseases of cultivated plants. Central Exp. Farm. Canada. Bull. 73: 1–57. 1913.
6. **Hecke, L.** Der Einfluss von Sorte und Temperatur auf den Steinbrandbefall. Zeitsch. Landw. Versuchsw. Oesterr. 12: 49–66. 1909.
7. **Heuser, W.** Versuche über den Einfluss äusserer Bedingungen auf die Stärke des Steinbrandbefalles des Weizens. Fühlings Landw. Zeitung 71: 81–99. 1922.
8. **Hungerford, C. W.** The relation of soil moisture and soil temperature to bunt infection in wheat. Phytopathology 12: 337–352. 1922.
9. **Munerati, O.** Osservazioni sulla recettività del frumento per la carie. Atti Accad. Lincei Cl. Sci. Fis. V. 31: 125–129. 1922.
10. ——. La basse temperature al momento della germinazione fanno sfuggire il grano all'attaco della carie? Atti Accad. Lincei Cl. Sci. Fis. V. 32: 285–289. 1923.
11. **Raines, M. A.** Vegetative vigor of the host as a factor influencing susceptibility and resistance to certain rust diseases of the higher plants. I. Am. Jour. Bot. 9: 183–203. 1922.

12. ——. Vegetative vigor of the host as a factor influencing susceptibility and resistance to certain rust diseases of the higher plants. II. Am. Jour. Bot. 9:215–238. 1922.
13. **Reed, George M.** Physiologic races of oat smuts. Am. Jour. Bot. 11:485–492. 1924.
14. ——. Varietal susceptibility of wheat to *Tilletia laevis* Kühn. Phytopathology 14:437–450. 1924.
15. **Reed, George M. & Faris, James A.** Influence of environal factors on the infection of sorghum and oats by smuts. I. Experiments with covered and loose kernel smuts of sorghum. Am. Jour. Bot. 11:518–534. Oct. 1924.
16. ——. Influence of environal factors on the infection of sorghum and oats by smuts. II. Experiments with the covered smut of oats and general considerations. Am. Jour. Bot. 11:579–599. 1924.
17. **Stakman, E. C.** A study in cereal rusts; physiological races. Minn. Agr. Exp. Sta. Bull. 133:1–56. 1914.
18. **Stephens, D. E. & Woolman, H. M.** The wheat bunt problem in Oregon. Ore. Agr. Exp. Sta. Bull. 188:1–42. 1922.
19. **Tubeuf, C. F. von.** Studien über die Brandkrankheiten des Getreides und ihre Bekämpfung. Arb. Biol. Abt. Land- und Forstw. Kaiserl. Gesundh. 2:179–372. 1901.
20. ——. Weitere Beitrage zur Kenntniss der Brandkrankheiten des Geitreides und ihrer Bekämpfung. Arb. Biol. Abt. Land- und Forstw. Kaiserl. Gesundh. 2:437–467. 1902.
21. **Volkart, A.** Die Bekämpfung des Steinbrandes des Weizens und des Kornes. Landw. Jahrb. Schweiz 20:445–490. 1906.
22. **Woolman, Horace M. & Humphrey, Harry B.** Summary of literature on bunt, or stinking smut, of wheat. U. S. Dept. Agric. Bull. 1210:1–44. 1924.

NOTES AND BRIEF ARTICLES

Professor Bruce Fink is spending his sabbatical leave at the New York Botanical Garden and other botanical centers looking over lichens preparatory to a monograph of that group of plants for the United States.

Mr. L. E. Wehmeyer of the University of Michigan spent a few days at the New York Botanical Garden looking over some of the fungi belonging to the family Valsaceae. He is especially interested in connecting these forms of ascomycetous fungi with their pycnidial stages.

"Mushrooms, Edible and Otherwise" is the title of a splendidly illustrated article by L. W. Brownell in the September number of *Nature Magazine*.

W. H. Long refers to *Cenangium Abietis* as one of the useful factors in bringing about self pruning of the western yellow pine, this pruning being essential to the production of clear lumber.

An extensive illustrated article appears in the June number of American Journal of Botany on the *Helminthosporium* disease of rice in the southern United States and the Philippine Islands, caused by *Helminthosporium Oryzae*.

In his "Revisión de las Meliolas Argentinas" C. Spegazzini (Anal. Mus. Hist. Nat. Buenos Aires 32: 339–393. 1924) records a number of new species of *Meliola* together with critical descriptions of those previously known from Argentine.

We learn from *Science* that Professor and Mrs. F. L. Stevens of the University of Illinois have left for a six months collecting

trip in South America. They expect to visit Panama, Ecuador, Peru, Bolivia, Chile, Argentine and Brazil, returning in February.

In *Phytopathology* for July, J. C. Walker reports the occurrence of white rot of onion in America caused by *Sclerotium cepivorum* Berk. G. B. Ramsey in the same number describes *Sclerotinia intermedia* n. sp. as the causal organism in the decay of salsify and carrots.

We are informed through *Science* that Mr. J. F. Rock, head of the National Geographic Society's expedition into southwestern Szechuan and southeastern Tibet, has just returned with a large collection of plants including a blight resistant chestnut tree. His collection of chestnuts include several species unknown to the horticultural world and possibly new to science.

Mushroom collectors are often puzzled by species of *Lactaria* parasitized with *Hypomyces Lactifluorum* which obliterates the gills and gives the entire host an orange color. Large specimens have recently been sent in for determination, the collector apparently not recognizing this phenomenon as a " fungus on a fungus."

Miss Anna E. Jenkins of the Department of Agriculture, Washington, spent a day at the New York Botanical Garden looking over the collections of Exoascales. Miss Jenkins is making a critical study of this order of parasitic fungi preparatory to a monograph of the species and would doubtless be glad to see fresh material from anyone caring to send it in. She also made a survey of the rose garden with special reference to brown rot, *Diaporthe umbrina*, a fungus which seems to be causing a great deal of damage to cultivated roses.

Under the title " Algunos Honguitos Portoriqueños " C. Spegazzini (Bol. Acad. Ci. Córdoba **26**: 335–368. 1923) describes the following genera: *Meliolidium* n. gen. based on *Meliolidium*

portoricense n. sp.; *Stevensula* n. gen. on *Stevensula monensis* n. sp.; *Lembosidium* n. gen. on *Lembosidium portoricense* n. sp.; *Melioliphila* n. gen. on *Calonectria graminicola* Stev.; *Amphinectria* n. gen. on *Amphinectria portoricensis* n. sp.; *Subiculicola* n. gen. on *Calonectria ambigua* Speg.; *Micropiltidium* n. gen. on *Micropeltidium monense* n. sp.; *Scolecopeltella* n. gen. on *Scolecopeltella microcarpa* n. sp.; and *Monospermella* n. gen. on *Monospermella portoricensis* n. sp. Also the following species not included above: *Trichomerium portoricense* n. sp.; *Morenoella portoricensis* n. sp.; *Micropeltidium portoricense* n. sp.; *Scolecopeltis portoricensis* n. sp.; *Scolecopeltis pachyasca* n. sp.; *Scolecopeltella portoricensis* n. sp.; *Puiggarina Ichnanthi* n. sp.; *Phyllachora orbicularis* n. sp.; *Dothidella andiricola* n. sp. A number of new forms were also described. Eight text figures are used in illustrating the species and genera described.

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